CHAPTER 4 – ENVIRONMENTAL EFFECTS

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4.0. ENVIRONMENTAL EFFECTS

4.1. Introduction

This chapter describes the effects of the MMPO and land disposal alternatives to the elements of the human environment (resources). A discussion of significance of an effect is required by 40 CFR 1502.16; however, the final determination of significance is the responsibility of the authorized officers for each ROD (Section 1.6). Note that most of the effects of the MMPO alternatives would be indirect effects from the mine operations on private land (which must also be analyzed under the NEPA). The direct effects for the MMPO alternatives would be primarily those from the expansion of the WRSFs and the TSF, and the relocation of the power line, i.e., the conversion of timber and recreational land to support areas for molybdenum mining. In any event, no additional analysis would reasonably be expected to cause a decision maker to reach a different decision – the fundamental threshold of adequate NEPA analysis. The effects of the MMPO and land disposal alternatives are evaluated in 16 sections:

4.2. Geologic Resources and Geotechnical Issues
4.3. Soil Resources
4.4. Vegetation, Forest Resources, and Invasive and Non-native Plants
4.5. Range Resources
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4.7. Wildlife Resources
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The information in these sections is summarized from the technical reports for each of the resources (JBR 2014a through JBR 2014p). These technical reports contain the references, data, modeling results, and other information used to form the effects analysis presented in this chapter. Note that the MMPO alternatives are independent (do not depend on the outcome) of the land disposal alternatives as the mine would not operate differently if TCMC acquired the selected land, which contains the southern portion of the mine. Therefore, the effects of the MMPO alternatives are evaluated separately from the effects of the land disposal alternatives, and the effects of the land disposal alternatives do not include repetition of any of the effects of the MMPO alternatives. The effects of the RMP amendment would be the same as the effects of the land disposal action alternatives.

For several resources including air quality and noise; socioeconomic factors; and transportation, access, and public safety; the effects would not vary meaningfully among the MMPO alternatives, except for their timing and duration (Table 4.1-1).

Table 4.1-1. Timing and duration of effects.

Alt.	2009	2016	2017	2020	2025	2026	2027	2030	2035
M1	M	M	CR	LSR	LTR	LTR	LTR	LTR	LTR
M2	M	M	M	M	M	CR	CR	LSR	LTR
M3	M	M	M	M	M	CR	CR	LSR	LTR

M = mining, CR = core reclamation, LSR = late-stage reclamation, LTR = long-term reclamation.

The magnitude of the effects is described according to criteria specific to each resource (Table 4.1-2). In addition, for effects with a magnitude greater than negligible, the duration of the effects is described: less than 1 year = temporary, 1 to 10 years = short term, greater than 10 years = long term. In a few cases the duration of an effect is described as permanent. The frequency of an effect is described only when such is key to understanding the effect. The magnitude, duration, and frequency descriptions are generally not provided for the no action alternative, which represents the baseline conditions against which to compare the action alternatives. Note that the effects for Alternative L2-B are evaluated under the headings for Alternative L2 only for resources for which there could be meaningful effects, i.e., there is not a parallel set of headings (Alternative L2-A and Alternative L2-B) for each resource.

Table 4.1-2. Effects determination criteria.

Resource	Negligible effect	Minor effect	Moderate effect	Major effect
Geologic Resources and Geotechnical Issues	A change to world annual production of molybdenum (550 million pounds) of < 0.1 % (< 550,000 pounds). A change to world molybdenum reserves (22 billion pounds) of < 0.1 % (< 22 million pounds).	A change to the world annual production of molybdenum of 0.1 to < 1 % (550,000 to < 5,500,000 pounds). A change to world molybdenum reserves of 0.1 to < 1 % (22 to < 220 million pounds).	A change to world annual production of molybdenum of 1 to < 5 % (5,500,000 to < 27,500,000 pounds). A change to world molybdenum reserves of 1 to < 5 % (220 million to < 1.1 billion pounds).	A change to world annual production of molybdenum of > 5 % (27,500,000 pounds). A change to world molybdenum reserves of > 5 % (> 1.1 billion pounds).
Soil Resources	The modification of soil resources would not be able to be meaningfully measured or evaluated by a trained observer.	There would be a detectable and slight change to soil characteristics (e.g., productivity, susceptibility to erosion) in < 10 % of an analysis area but the change would not increase the potential for soil loss.	The changes would include change to soil characteristics (e.g., productivity, susceptibility to erosion) in 10 to 25 % of an analysis area.	The changes would include change to soil characteristics (e.g., productivity, susceptibility to erosion) in > 25 % of an analysis area.
Vegetation, Forest Resources, and Invasive and Non-native Plants	Changes to vegetation resources would not be able to be meaningfully measured or evaluated by a trained observer.	Changes would be limited to small areas, e.g., < 10 % of the resource in the analysis area. The severity and timing of changes would be expected to be within natural variability and not expected to cause long-term changes to plant communities. Key ecosystem processes may	Changes would be readily apparent and/or would affect 10 to 25 % of vegetation cover in the analysis area. The severity and timing of changes would be expected to be outside the natural variability for short periods and changes within natural variability may be long term. Key	Changes would affect > 25 % of vegetation cover in the analysis area. The severity and timing of changes would be expected to be outside natural variability for short to long periods. Changes within natural variability may be long term. In extreme cases, species might be

Resource	Negligible effect	Minor effect	Moderate effect	Major effect
		have short-term disruptions within natural variability, but habitat for all species would remain functional.	ecosystem processes may have short-term disruptions outside natural variability, but habitat for all species would remain functional.	extirpated from the analysis area and key ecosystem processes might be disrupted, or habitat for species rendered not functional.
Range Resources	No meaningful changes to range resources, including range access.	Changes would be slight, but detectable by standard measurement. The severity and timing of changes would not be expected to be outside natural variability and would not be expected to require adjustments to season of use, distribution of livestock, or livestock numbers. There would be a change of no more than 10 % in the available AUMs in an allotment.	Changes would be apparent and the severity and timing of changes would be expected to be outside natural variability. However, the changes would be mitigated by minor adjustments to the season of use or distribution of livestock. There would be a change of no more than 25 % in the available AUMs in an allotment.	Changes would be distinct and the severity and timing of changes would be expected to be outside natural variability. The changes would not be able to be mitigated, or would require substantial adjustments to the season of use, distribution of livestock, or livestock numbers. The majority of an allotment or a substantial portion of the water supply used by livestock would be materially altered, including by changes in access to an allotment. There would be a change of more than 25 % of the available AUMs in an allotment.

Resource	Negligible effect	Minor effect	Moderate effect	Major effect
Water Resources	There would be no detectable changes by standard measurements to local water quality and availability.	Changes to water quality would be detectable, but well below all applicable surface water and groundwater WQSs. Changes to water quantity would be limited to the permitted mine area.	Changes to water quality would potentially reach applicable WQSs and would potentially affect organisms or natural ecological processes. If affected, the effects would be at the lowest levels of standard biological or ecological evaluation. Changes to water quantity would occur outside the permitted mine area but would not affect other existing water rights.	Changes to water quality would potentially equal or exceed applicable WQSs and would be expected to affect organisms or natural ecological processes. Such effects would be expected to be readily apparent in standard biological or ecological evaluation. Changes to water quantity would meaningfully affect other existing water rights.
Wildlife Resources	Changes to habitat would not be able to be meaningfully measured or evaluated by a trained observer.	Changes to habitat or individuals of a species would be detectable, primarily at the scale of individuals in a localized area. There would be no changes to the viability of a local population or habitat capability.	Changes to habitat or individuals of a species would be readily detectable and sufficient to cause changes at the scale of a local population. The changes may be a reduction in population numbers, density, or habitat capability that might reduce the distribution of a species in an analysis area.	Changes to habitat or individuals of a species would be obvious and sufficient to affect a local population and possibly a regional population. The changes would probably be a reduction in local population numbers, density, or habitat capability to the point that the distribution of a species in an analysis area would be substantially reduced or eliminated, and the population would probably not return to a sustainable level.

Resource	Negligible effect	Minor effect	Moderate effect	Major effect
Fish and Aquatic Resources	Changes to habitat or species would not be able to be meaningfully measured or evaluated by a trained observer.	Changes would be noticeable primarily at the scale of individuals, with no changes to long-term population numbers, distribution, or ecological function. Changes would not be expected to be outside natural variability and habitat for the species would remain functional.	Changes to habitat or individuals of a species would be sufficient to cause effects at the scale of a local population. There might be a reduction in habitat suitability for a species, a population decline, a reduction in the distribution of a species, and/or impairment of ecological function. However, the changes would probably not appreciably reduce the probability of the survival of the species in the analysis area.	Changes would probably reduce long-term habitat suitability for a species, lead to a decrease in population viability, and/or disrupt ecological function. The probability of the survival of a species in the analysis area would be appreciably reduced, possibly to zero.
Wetlands, Floodplains, and Riparian Areas	Changes in wetland size, function, or continuity would not be able to be meaningfully measured or evaluated by a trained observer.	Changes would be measurable or perceptible to a trained observer. Up to a 10 % change in size, function, or continuity of these resources in the analysis area would occur due to indirect effects such as changes in water quantity and quality changes. However, the overall viability of the resource would not be affected.	A 10 to 25 % change in the size, function, or continuity of these resources in an analysis area.	A change of > 25 % in size, function, and continuity of these resources in an analysis area. The change would be substantial and distinctly noticeable.

Resource	Negligible effect	Minor effect	Moderate effect	Major effect
Air Quality and Noise	The change in the concentration of any criteria pollutant would be less than any Class II SIL (< ~ 5 % of an NAAQS), and would not exceed any NAAQS for any residential receptors in the analysis area. The change in sound level in an analysis area (outside the mine site) would not be perceptible to key receptors (≤ 3 dBA L_{DN}).	A change in the concentration of any criteria pollutant of 5 to < 25 % of an NAAQS, and no exceedance of any NAAQS for any residential receptors in an analysis area. A change in sound level in an analysis area (outside the mine site) that would be barely perceptible to clearly perceptible to key receptors (3 to < 6 dBA L_{DN}).	A change in the concentration of any criteria pollutant of 25 to 75 % of an NAAQS, and no exceedance of any NAAQS for any residential receptors in an analysis area. A change in sound level in an analysis area (outside the mine site) that would be clearly perceptible to receptors (≥ 6 to < 10 dBA L_{DN}).	A change in the concentration of any criteria pollutant of > 75 % of an NAAQS, and no exceedance of any NAAQS for any residential receptor in an analysis area. A change in sound level in an analysis area (outside the mine site) that would be distinctly perceptible (i.e., twice as loud or half as loud) to key receptors (≥ 10 dBA L_{DN}), e.g., a change of 15 dBA would be equivalent to the typical outdoor to indoor sound reduction.
Climate Change	The direct emissions of CO_2e for an alternative would be < 0.025 MT/year, the conservative, de minimis amount suggested by CEQ (2010).	The direct emissions of CO_2e for an alternative would be 0.025 MT/year to < 6 MT/year, equivalent at the upper range to the emissions from a medium-size, coal-fired power plant using current technology.	The direct emissions of CO_2e for an alternative would be 6 MT/year to 60 MT/year, equivalent at the upper range to the emissions of five, large, coal-fired power plants using current technology.	The direct emissions of CO_2e for an alternative would be > 60 MT/year.

Resource	Negligible effect	Minor effect	Moderate effect	Major effect
Visual (Aesthetic) Resources	None of the element contrasts of the characteristic landscape from the KOPs would be visible or perceived by a trained observer. VRM class/VQOs would be met for an analysis area.	There would be perceptible changes to one or more element contrasts of the visual landscape from KOPs. Trained observers may notice low levels of contrasts, but the overall quality of the visual landscape would not substantially change. The level of contrast in the visual landscape would meet the current VRM class/VQOs established for an analysis area.	One or more of the feature contrasts could attract attention from casual observers at one or more KOPs, and would begin to become dominant in the visual landscape. The level of contrast in the visual landscape would not meet the current VRM class/VQOs established for an analysis area.	One or more feature contrasts would dominate the attention of a casual observer at one or more KOPs, and would be dominant in the visual landscape. The level of contrast in the visual landscape would not meet the current VRM class/VQOs established for an analysis area.
Land Use and Recreation	There would be no perceptible change in land uses. Changes to the quality of recreation would not be noticeable to individuals currently recreating in the area. There would be no change in the number of visitors to an analysis area.	There would be a change in land use conditions that would alter up to how 10 % of the land was used. Changes to the quality of recreation would be noticeable to some individuals currently recreating in the area, but would not substantially affect the quality of recreation in an analysis area.	There would be a change in land use conditions that would alter how 11 to 25 % of the land was used. Changes to the quality of recreation would be noticeable to most individuals currently recreating in the area, and would substantially affect the quality of some of the key recreational characteristics, e.g., prohibitions would be placed on motorized access.	There would be a change in land use conditions that would alter how > 25 % of the land was used. Changes to the quality of recreation would be noticeable to nearly all individuals currently recreating or wishing to recreate in the area, and would substantially affect the quality of many of the key recreational characteristics, e.g., prohibitions would be placed on most of the recreational activities or

Resource	Negligible effect	Minor effect	Moderate effect	Major effect
				public access to the area. The area generally would no longer be available for recreational use, or the experience would be so diminished that the area generally would not be used for recreation.
Socioeconomic Factors	There would be no perceptible changes to any socioeconomic condition.	A change to a socioeconomic condition that would be perceptible to only a few residents, e.g., a change of < 1 % in the population or a gain/loss of < 3 jobs in Custer County. A minor change to a socioeconomic condition for only a few residents, e.g., a change in property value/income of < 3 %. The socioeconomic character of an analysis area would not change.	A change to a socioeconomic condition that would be perceptible to a few percent of the residents, e.g., a change of 1 to 10 % in the population or a gain/loss of 3 to 15 jobs in Custer County. A minor change to a socioeconomic condition for a few percent of the residents, e.g., a change in property value/income of < 3 %. There would be a slightly perceptible change to the socioeconomic character of an analysis area.	A change to a socioeconomic condition that would be perceptible to most residents, e.g., a change of > 10 % in the population or a gain/loss of > 15 jobs in Custer County. A minor change to a socioeconomic condition for many residents, or a major change to a socioeconomic condition for a few residents such as a change in property value/income of ≥ 3 %. There would be a readily apparent change to the socioeconomic character of an analysis area.

Resource	Negligible effect	Minor effect	Moderate effect	Major effect
Tribal Treaty Rights and Interests	There would be no perceptible change to features that are integral in maintaining the cultural and religious identity of a Native American community. The action would not conflict with Tribal treaty rights and interests. There would be no change in the amount of unoccupied Federal land in an analysis area.	Adverse: There would be a slightly perceptible change to features that are integral in maintaining the cultural and religious identity of a Native American community that would slightly diminish the relationship between these features and the community's cultural and religious identity. There may be a limited change to traditional resource access and Tribal treaty rights. There would be a net decrease of < 1 % in the unoccupied Federal land in the analysis area. Beneficial: The action would allow/enhance traditional resource access and Tribal treaty rights. There would be a net gain of < 1 % of the unoccupied Federal land in an analysis area.	Adverse: There would be a substantial change to features that are integral in maintaining the cultural and religious identity of a Native American community that would interfere with the relationship between these features and the community, but the cultural and religious identity would be generally intact. There would be substantial interference with traditional resource access and/or Tribal treaty rights. There would be a net decrease of 1 to 5 % in the unoccupied Federal land in an analysis area. Beneficial: The action would enhance or improve traditional resource access and/or Tribal treaty rights. There would be a net gain of 1 to 5 % of the unoccupied Federal land in an analysis area.	Adverse: There would be a substantial change to features that are integral in maintaining the cultural and religious identity of a Native American community to such an extent that the cultural and religious identity could be lost. There would be substantial interference or elimination of traditional resource access and/or Tribal treaty rights. There would be a net decrease of > 5 % in the unoccupied Federal land in an analysis area. Beneficial: The action would substantially enhance or improve traditional resource access and/or Tribal treaty rights. There would be a net gain of > 5 % in the unoccupied Federal land in an analysis area.

Resource	Negligible effect	Minor effect	Moderate effect	Major effect
Cultural Resources	There would be no perceptible consequences for archaeological resources, cultural landscapes, or historic structures. The Section 106 determination would be no historic properties affected.	Adverse: There would be a slight, measurable, and perceptible effect that would be permanent, but the effect would be to a limited area of a site or group of sites or few of a cultural landscape's features. The Section 106 determination would be adverse effect. Beneficial: Small areas of a site, group of sites, structures, or features of a cultural landscape would be preserved.	Adverse: There would be a measurable and perceptible effect that would be permanent. The effect would change one or more of the features or characteristics of the site, structure, or landscape that would qualify the site, structure or landscape for the National Historic Register and somewhat diminish the integrity of the site, structure or landscape. The Section 106 determination would be adverse effect. Beneficial: The action would noticeably enhance the preservation and protection of the site, structure, or landscape.	Adverse: There would be a substantially measurable and perceptible effect that would be permanent. The effect would change one or more of the features of the site, structure, or landscape and would diminish the integrity to such an extent that it would no longer be eligible for listing on the National Historic Register. The Section 106 determination would be adverse effect. Beneficial: The action would substantially enhance the preservation and protection of the site, structure, or landscape.

Resource	Negligible effect	Minor effect	Moderate effect	Major effect
Transportation, Access, and Public Safety	Changes would not be noticeable to most visitors to an analysis area. See Land Use and Recreation above for the description for Access. For public safety, there would not be proportionally more injury or illness, apart from injury or illness requiring only very basic first aid.	Changes would be apparent to some (e.g., < 25 %) visitors to an analysis area. Changes would cause somewhat shorter or longer travel times; increase or decrease in access to very limited areas; change in access type (e.g., motorized versus non-motorized) on minor access routes; etc. For public safety, there would be a change that would cause a proportional increase in injury or illness resulting in lost workday(s).	Changes would be apparent to many (e.g., > 25 %) visitors to an analysis area. Changes would cause distinctly shorter or longer travel times; decrease or increase in access to more extensive areas; change in access type (e.g., motorized versus non-motorized) on major access routes; somewhat alter the character of an analysis area; etc. For public safety, there would be a change that would cause a proportional increase in injury or illness involving permanent partial disability or temporary total disability.	Changes would be apparent to most people visiting an analysis area. Changes would distinctly alter the character of an analysis area, e.g., year-round closure of a major access route such as the S.[1] Creek Road, or increase or decrease of access to 1,000s acres. For public safety, there would be a change that would cause death or permanent total disability.

[1] *Squaw Creek* is an official place name in Custer County, and appears in numerous published documents including US Geological Survey topographic maps. The name was established by the US Board of Geographic Names to maintain uniform geographic name usage throughout the Federal Government. However, the word *squaw* is offensive to some people including the Shoshone-Bannock Tribes. Therefore, *Squaw Creek* is hereafter referred to in the main text as *S. Creek*.

4.2. Geologic Resources and Geotechnical Issues

4.2.1. MMPO Alternatives

4.2.1.1. Alternative M1 – No Action Alternative

The open pit would continue to provide comprehensive exposure (~ ½ mile vertical height) of metasedimentary, granitic, and volcanic rocks, as well as geologic structures such as faults and fractures. The Federal land at the mine (most of the mine is on private land not subject to mining claims) would continue to be covered by mining claims owned by TCMC. The company would continue to explore some of the claims for molybdenum. There would be a very low probability in the foreseeable future of leasable mineral development on Federal lands at the mine, and there would be no salable mineral development on Federal lands at the mine. The mine would produce approximately 15 to 20 million pounds of molybdenum per year or 73 million pounds of molybdenum by March 2016. The mine would also produce 174 million tons of waste rock and generate tailings. No additional production of molybdenum would occur after 2016.

Extensive and detailed site-specific geotechnical analyses demonstrate stability under both static and dynamic conditions (i.e., seismic shaking) for the pit walls, the WRSFs, and the TSF (CNI 2011; Golder 2007, 2010; KP 2011a, 2011b, 2013; URS 2000; VTN 1980b). The facilities would be stable during even the maximum credible earthquake during both mining and post-reclamation. The maximum credible earthquake would cause only small-scale (e.g., bench-scale or less) rock fall from the surfaces of the pit walls. There could be slight settling slumps (e.g., 12 inches) in the tops of the WRSFs and rocks rolling from surfaces of the faces of the facilities, but there would not be collapse of buildings, breach of fuel tanks (which would drain to containment basins), fault scarps (no major active faults at the mine site), or major collapse of a facility (including the TSF) at the mine. Over hundreds of years the pit walls would gradually slough and ravel to cover the faces and floors of the benches producing relatively smooth pit wall slopes.

There are no known paleontological resources and low potential for meaningful paleontological resources in the analysis area, apart from the Bruno Creek fossil outcrop. However, the Bruno Creek outcrop would continue to be unaffected by mining and would not be accessible to the public during the mine life due to the exclusive easement held by TCMC for Bruno Creek Road. The outcrop would be more accessible to paleontological collection by the public (i.e., reasonable amounts of common invertebrate and plant paleontological resources as allowed by 16 USC 470aaa(1) and 43 CFR 8365.1-5) after reclamation if the public were allowed to use the Bruno Creek Road during late-stage reclamation.

4.2.1.2. Alternative M2 – MMPO as Submitted by TCMC

The open pit would expose an additional 250 vertical feet of granitic rock in the base of the pit (negligible effect to geologic resources/physiography). The mine would produce 10 to 20 million pounds of molybdenum per year, or an additional 131 million pounds of molybdenum during 9 years (short-term, moderate effect to world molybdenum production and short-term, minor effect to world molybdenum reserves). The mine would also produce an additional 96 million tons of waste rock. The key mine facilities would be stable under both static and

dynamic conditions (CNI 2011; Golder 2007, 2010; KP 2011a, 2011b; KP 2013; URS 2000; VTN 1980b) (no effect).

There would be no meaningful effects to paleontological resources, i.e., no effect to the Bruno Creek fossil outcrop and low potential for the discovery of meaningful paleontological resources in the analysis area (negligible effect).

4.2.1.3. Alternative M3 – No Name Waste Rock Storage Facility

The mine would have the same effects to world molybdenum production and reserves and produce the same amount of waste rock as for Alternative M2. However, the No Name WRSF would contain approximately 115 million tons, and the Pat Hughes and Buckskin WRSFs would contain that much less waste rock. The No Name WRSF would be developed using the same fundamental design as that of the Pat Hughes and Buckskin WRSFs; therefore, the geotechnical issues (i.e., stability) of the No Name WRSF would be the same as those under Alternative M1 and Alternative M2.

The effects to paleontological resources would be the same as under Alternative M1.

4.2.2. Land Disposal Alternatives

4.2.2.1. Alternative L1 – No Action

The selected land would continue to be covered by mining claims owned by TCMC, and has not been available for locatable mineral entry under Federal mining laws by anyone other than the owner of the mine since the late 1960s to early 1970s. In addition, the BLM has no records of any disposals of salable minerals from the selected land. The probability of meaningful mineral development (locatable, leasable, or salable) of the selected land in the foreseeable future, apart from that for support operations for the mine, would be very low. The minerals on the offered lands would continue to be owned by the land owner (currently TCMC), and would be unavailable to mineral entry under Federal mining laws. Small quantities (e.g., < 50 tons/year) of quartzite talus may be sold from the Broken Wing Ranch during some years for use as decorative rock and building stone. However, there would be little probability that meaningful mineral development would occur at either the ranch or the Garden Creek property.

There would be no change in the jurisdiction of paleontological resources.

4.2.2.2. Alternative L2 – Land Exchange Proposal

The selected land would become private land no longer available under Federal laws and regulations for mineral entry for locatable or leasable minerals, or for disposal of salable minerals. However, the selected land has not been available for locatable mineral entry by anyone other than the owner of the mine since the late 1960s and early 1970s. Also, there would be a very low probability in the foreseeable future of leasable or salable mineral development on the selected land (minerals used in support of the mine such as colluvium for reclamation would be acquired under the Federal mining laws and not sold by the BLM as a salable mineral).

The US would acquire the mineral estates of the offered lands by donation from TCMC, and the offered lands would not be subject to the land and mineral laws unless the BLM issued a public land order to that effect (43 CFR 2091.8). The BLM does not presently intend to issue such order. Therefore, the offered lands would not be open to locatable, leasable, or salable mineral operations in the foreseeable future. Regardless, the BLM would probably not dispose of quartzite or other salable minerals such as sand and gravel from the ranch, since similar materials are available from nearby sites on other BLM land and are widely available in the region from existing quarries and gravel pits. Similarly, even if the Garden Creek property were available for disposal of salable minerals, the BLM would probably not dispose of such minerals from the property because of its isolated location. The probability of a valuable locatable or leasable mineral deposit occurring at the offered lands would be very low. All of these effects would be negligible. However, the geologic resources of the Broken Wing Ranch and the upper Lyon Creek drainage would be readily available for rockhounding, field inspection, or study by the public (e.g., the Boise State University geology department) (long-term, minor effect).

The Bruno Creek fossil outcrop, as private property, would not be available for paleontological collection by the public and would be protected by a conservation easement along the portion of S. Creek on the selected land. However, under Alternative L2 the outcrop would not be available to the public during the foreseeable future due to the exclusive easement held by TCMC for the Bruno Creek Road (negligible effect).

4.2.2.3. Alternative L3 – Land Sale

The effects would be the same as for Alternative L2 regarding the selected land, and the same as for Alternative L1 regarding the offered lands, except the geologic resources of the Broken Wing Ranch would not be available (and those of the upper Lyon Creek drainage would not be readily available) for rockhounding, field inspection, or study by the public (long-term, minor effect). In addition, if the selected land was sold to a party other than TCMC, the mineral rights for the property and the right to extract the minerals would be reserved to the US for continued use by TCMC (long-term, major effects).

Due to the lack of known paleontological resources or rocks with high potential for meaningful paleontological resources at the offered lands, the effect to paleontological resources would be the same as for Alternative L2 (negligible effect).

4.2.2.4. Alternative L4 – Reduced Area Land Exchange, Fee Simple

Compared to Alternative L2 and Alternative L3, approximately 1,500 acres of the selected land would remain open to mineral entry and disposal of salable minerals. However, locatable mineral entry in the foreseeable future by anyone other than TCMC would be precluded by the existing mining claims on the 1,500 acres. Compared to Alternative L2, approximately 30 percent less (by fair market value) offered lands would be acquired by the US and would become open to mineral entry and disposal of salable minerals (negligible effects).

The effects to paleontological resources would be the same as for Alternative L2 (negligible effect), i.e., the effects would not vary with the amount of selected land that would become privately owned or the amount of offered lands acquired by the US.

4.2.2.5. Alternative L5 – Reduced Area Land Exchange, Easement

The effects regarding the selected land would be the same as for Alternative L2, except there would be no probability of locatable, leasable, or salable mineral development on the approximately 1,500 acres covered by the conservation easement. The effects regarding the offered lands would be the same as for Alternative L4, except more (by fair market value) of the offered lands would be acquired by the US and would become open to mineral entry and disposal of salable minerals (e.g., only ~ 10 % less by fair market value compared to Alternative L2) (negligible effects).

The effects to paleontological resources would be the same as for Alternative L4.

4.3. Soil Resources

4.3.1. MMPO Alternatives

4.3.1.1. Alternative M1 – No Action

The erosion (wind and water), compaction, and loss of soil would continue at the mine as it has for the last 30 years. Most of the lifetime soil loss at the mine was during soil removal and storage for the initial mine development during 1981 to 1983. Most of the current soil loss is from the Bruno Creek access road and general fugitive dust (Section 4.10.1.1). TCMC has not had to remove sediment from the two Bruno Creek sedimentation ponds since the sediment windows (traps) were installed along Bruno Creek Road in 1988 (Doughty 2013). The sediment traps are typically cleaned twice each year for an annual sediment loss from the road of approximately 80 cubic yards (~ 40 traps, ~ 1 cubic yard/clean out). The sediment (high-quality soil) is stockpiled at various soil salvage piles, protected from erosion (e.g., Photo 2.1-18.), and used in mine reclamation (Natoli 2013).

4.3.1.2. Alternative M2 – MMPO as Submitted by TCMC

By the end of active mining, the expansion of the WRSFs and the TSF would cause 336.0 acres of soil to be removed (or inundated in the case of the TSF). Soil on an additional 112.1 acres associated with the pipeline, power line, and operational areas would be compacted and/or removed and replaced by construction activities (Table 4.3-1). The final reclamation grading of the TSF would affect an additional 48.9 acres of soil. The compaction of soil would disrupt soil textures and reduce soil productivity. The removal (± storage) and replacement of soil would destroy soil textures and cause soil loss due to wind and water erosion, with a resulting loss of nutrients, organic matter, and microbial communities in the soil. Therefore, the soil replaced during reclamation (all areas except the open pit) would have decreased soil productivity and increased susceptibility to erosion, particularly on steeper slopes and/or relatively erodible soil (short-term, moderate to major effects) (Table 4.3-1., Table 4.3-2). These effects would be mitigated during reclamation by erosion controls and revegetation (negligible to moderate effects, depending primarily on slope, soil erodibility, and amount of revegetation) (Table 4.3-3). Soil erosion would increase sediment delivery to surface water (Section 4.6).

Table 4.3-1. Soil erodibility, Alternative M2.

Disturbance Area	Soil Erodibility		TOTAL
	High	Moderate	
Buckskin WRSF[1]	0	63.8	63.8
Pat Hughes WRSF[1]	0	189.9	189.9
TSF[1]	0	131.2	131.2
Subtotal	**0**	**384.9**	**384.9**
Operational Area	4.4	66.0	70.4
Pipeline	0	19.7	19.7
Pit	0	0	0
Power Line	8.0	14.0	22.0
Subtotal	**12.4**	**99.7**	**112.1**
TOTAL	**12.4**	**484.6**	**497.0**

[1] Soil erodibility determined using data and characteristics for borrow soil assumed to be used for cover soil.

Table 4.3-2. Soil effects during mining, Alternative M2.

Duration	Disturbance Area	Effects		TOTAL
		Major	Moderate	
Long term	Buckskin WRSF[1]	31.9	31.9	63.8
	Pat Hughes WRSF[1]	95.0	95.0	189.9
	TSF[1]	28.8	53.5	82.3
	Subtotal	**155.7**	**180.4**	**336.0**
Temporary	Operational Area	55.3	15.1	70.4
	Pipeline	17.7	2.0	19.7
	Pit	0	0	0
	Power Line	20.4	1.6	22.0
	Subtotal	**93.4**	**18.7**	**112.1**
	TOTAL	**249.1**	**199.1**	**448.1**

[1] Effects determined using data and characteristics for borrow soil assumed to be used for cover soil; final grade slopes for WRSF footprint assumed to be 50 % at > 30 % slope and 50 % between 8 and 15 %; post-mining grade slopes for TSF footprint presumed to be 35 % at > 30 % slope and 65 % at < 5 % slope.

Table 4.3-3. Post-reclamation effects to soil, Alternative M2.

Duration	Disturbance Area	Effects			TOTAL
		Moderate	Minor	Negligible	
Long term	Buckskin WRSF[1]	31.9	31.9	0.0	63.8
	Pat Hughes WRSF[1]	95.0	95.0	0.0	189.9
	TSF[1]	45.9	0.0	85.3	131.2
	Subtotal	**172.8**	**126.9**	**85.3**	**384.9**
Temporary	Operational Area	38.4	25.0	7.0	70.4
	Pipeline	15.0	3.6	1.1	19.7
	Pit	0	0	0	0
	Power Line	15.6	4.8	1.6	22.0
	Subtotal	**69.0**	**33.4**	**9.7**	**112.1**
	TOTAL	**241.8**	**160.3**	**95.0**	**497**

[1] Effects determined using data and characteristics for presumed borrow soil to be used for cover soil; final grade slopes for WRSF footprint assumed to be 50 % at > 30 % slope and 50 % between 8 and 15 % slope; final grade slopes for TSF footprint assumed to be 35 % at > 30 % slope and 65 % at < 5 % slope.

4.3.1.3. Alternative M3 – No Name Waste Rock Storage Facility

By the end of active mining, the expansion of the WRSFs and the TSF would cause 477.6 acres of soil to be removed (or inundated in the case of the TSF), 141.6 acres more than under Alternative M2. Soil would be salvaged from the Pat Hughes WRSF (8.5 acres) and the No Name WRSF (4.0 acres) as part of the construction of the underdrains for these facilities. However, there would be less soil removed from the Pat Hughes and Buckskin WRSFs due to their smaller size (Table 4.3-4., Table 4.3-5., Table 4.3-6).

Table 4.3-4. Soil erodibility, Alternative M3.

Disturbance Area	Soil Erodibility		TOTAL
	High	Moderate	
Buckskin WRSF	0	0	0
No Name WRSF[1]	0	233.5	233.5
Pat Hughes WRSF[1]	0	161.8	161.8
TSF[1]	0	131.2	131.2
Subtotal	**0**	**526.5**	**526.5**
Operational Area	4.4	66.0	70.4
Pipeline	0	19.7	19.7
Pit	0	0	0
Power Line	8.0	14.0	22.0
Subtotal	**12.4**	**99.7**	**112.1**
TOTAL	**12.4**	**626.2**	**638.6**

[1] Soil erodibility determined using data and characteristics for presumed borrow soil to be used for cover soil.

Table 4.3-5. Soil effects during mining, Alternative M3.

Duration	Disturbance Area	Effects		TOTAL
		Major	Moderate	
Long term	Buckskin WRSF	0	0	0
	No Name WRSF[1]	116.8	116.8	233.5
	Pat Hughes WRSF[1]	80.9	80.9	161.8
	TSF[1]	28.8	53.5	82.3
	Subtotal	**226.5**	**251.2**	**477.6**
Temporary	Operational Area	55.3	15.1	70.4
	Pipeline	17.7	2.0	19.7
	Pit	0	0	0
	Power Line	20.4	1.6	22.0
	Subtotal	**93.4**	**18.7**	**112.1**
	TOTAL	**319.9**	**269.9**	**589.7**

[1] Effects determined using data and characteristics for presumed borrow soil to be used for cover soil; final grade slopes for WRSF footprint assumed to be 50 % at > 30 % slope and 50 % between 8 and 15 % slope; post-mining grade slopes for TSF footprint assumed to be 35 % at > 30 % slope and 65 % at < 5 % slope.

Table 4.3-6. Post-reclamation effects to soil, Alternative M3.

Duration	Disturbance Area	Effects			TOTAL
		Moderate	Minor	Negligible	
Long term	Buckskin WRSF	0	0	0	0
	No Name WRSF[1]	116.8	116.8	0.0	233.6
	Pat Hughes WRSF[1]	80.9	80.9	0.0	161.8
	TSF[1]	45.9	0.0	85.3	131.2
	Subtotal	**243.6**	**197.7**	**85.3**	**526.6**
Temporary	Operational Area	38.4	25.0	7.0	70.4
	Pipeline	15.0	3.6	1.1	19.7
	Pit	0	0	0.0	0
	Power Line	15.6	4.8	1.6	22.0
	Subtotal	**69.0**	**33.4**	**9.7**	**112.1**
	TOTAL	**312.6**	**231.1**	**95.0**	**638.7**

[1] Effects determined using data and characteristics for borrow soil assumed to be used for cover soil; final grade slopes for WRSF footprint assumed to be 50 % at > 30 % slope and 50 % between 8 and 15 % slope; final grade slopes for TSF footprint assumed to be 35 % at > 30 % slope and 65 % at < 5 % slope.

4.3.2. Land Disposal Alternatives

4.3.2.1. Alternative L1 – No Action

It is unknown how the Broken Wing Ranch and Garden Creek property would be managed in the foreseeable future. However, in the short term the ranch would probably be managed to produce hay and for cattle grazing with a reasonable probability of limited residential development (e.g., a few houses) along the Salmon River, and the Garden Creek property would probably remain undeveloped or have limited residential development. The benefits to riparian soil from the BLM ranch management strategies would not occur (exclusion of cattle, increased riparian vegetation, resting BWR-7 from grazing, etc.).

4.3.2.2. Alternative L2 – Land Exchange Proposal

There would be no effects to soil on the selected land, except for the portion of the land that would be affected by the MMPO alternatives (Section 4.3.1). The improvements at the ranch (e.g., widening roads, kiosks, campground) would result in small areas of soil compaction and increased soil erosion, especially in areas where vehicles would be present (parking areas, campground). The riparian areas would continue to be fenced to exclude cattle, which would reduce soil compaction in these areas if cattle were on the ground when it was wet, and would (along with the development of more riparian vegetation, particularly along lower Lyon Creek per the Lyon Creek conceptual restoration plan) reduce soil erosion/loss (long-term, negligible to minor effects).

Under L2-B approximately half (52 %) of the soil at the ranch would be fundamentally altered by the conversion to native vegetation, e.g., increased organic matter/microbial biomass/carbon sequestration; reduced bulk density (no equipment compaction); development of biological crusts; etc. (long-term, major effect). Soil erosion/loss would be comparable to that of the cultivated fields (Section 3.3.2.), except perhaps an increase by 1 order of magnitude before native vegetation was well established (negligible effect). An increase in public use at the Garden Creek property could cause slight soil compaction and erosion in a few places used for hiking, berry picking, camping, etc. (negligible effect).

4.3.2.3. Alternative L3 – Land Sale

The effects to the selected land would be the same as under Alternative L2. The effects to the offered lands under Alternative L2 would not occur; therefore, the effects to the offered land would be the same as under Alternative L1. There could be additional soil compaction/erosion/loss from limited residential development on the Broken Wing Ranch and Garden Creek property (short-term, negligible to minor effects).

4.3.2.4. Alternative L4 – Reduced Area Land Exchange, Fee Simple

The effects would be the same as under Alternative L3, except some of the ranch subparcels and/or the Garden Creek property would not be acquired by the US. The soil on such lands would be subject to compaction/erosion/loss from limited residential development (short-term, negligible to minor effects).

4.3.2.5. Alternative L5 – Reduced Area Land Exchange, Easement

The effects would be the same as under Alternative L4.

4.4. Vegetation, Forest Resources, and Invasive and Non-native Plants

4.4.1. MMPO Alternatives

4.4.1.1. Alternative M1 – No Action

There would be no change to the existing vegetation (plant or tree) communities, patterns, or productivity/carbon sequestration during mining. The management of weeds would not change. There would not be disturbance to suitable special status plant habitat. After mining (~ 2016), soil would be replaced and revegetation would occur on all of the disturbed areas except the open pit and infrastructure required for long-term water management (e.g., certain roads, buildings, power lines, and pipelines). Reclaimed areas would initially be grassland (forbs and grasses) in primary ecological succession.[2] Over several years the vegetation would evolve to grassland and shrubland, and then shrubland and conifer (lodgepole) seedlings. In perhaps a decade the vegetation would evolve to shrubland with scattered conifer saplings. Over decades the vegetation would evolve to young and then mature conifer shrubland or conifer forest, with old growth conifer trees developing as the climax species in 120 to 150 years (USFS 1992).

[2] the growth of pioneer species on land not previously vegetated, as opposed to the growth of pioneer species on land where the vegetation has been destroyed but without severe disturbance to soil

4.4.1.2. Alternative M2 – MMPO as Submitted by TCMC

A total of 497.0 acres of primarily upland vegetation would be removed during mining, primarily conifer forests (391.0 acres) and shrubland (62.0 acres) (Table 4.4-1). However, these vegetation communities are common in Custer County and in the area around the mine, i.e., no unique vegetation communities would be affected (short-term to long-term, major effects). There would be an increased probability of noxious weeds in the disturbed areas (long-term, moderate effect). Despite substantial fugitive dust suppression, deposition of fugitive dust near roads would affect photosynthesis, respiration, transpiration, and reproductive rates of vegetation near roads (negligible effect). Sensitive species would not be removed, but the species would be indirectly affected by the removal of their suitable habitat, particularly that for whitebark pine at the highest elevations. However, such effects would be so minimal as not to cause a trend toward listing under the ESA (long-term, minor effect).

Timber (2,548 mbf) would be harvested in phases during 14 to 15 years from 391.0 acres prior to expansion of the WRSFs and the TSF, which would affect forest diversity and timber production (long-term, moderate effect). More specifically, 84 acres of Douglas-fir, Douglas-fir/lodgepole pine, and mixed subalpine fir forests would be removed at the TSF; 14 acres of Douglas-fir plant communities would be removed for new pipelines (primarily around the perimeter of the TSF); 0.67 acre of subalpine fir/elk sedge would be removed at the open pit; and 22 acres mostly subalpine fir/elk sedge would be removed for the power line relocations. Trees growing in the power line corridors would also be removed or trimmed to minimize the probability of falling trees or wildfire damaging the power lines (long-term, minor effect). Timber harvest would follow BLM and Forest Service BMPs which were designed specifically to reduce sedimentation and protect soil qualities.

Table 4.4-1. Vegetation disturbance, Alternative M2.

Jdx.[1]	Developed/ Disturbed	Barren/Rock	Douglas-fir/ Elk Sedge	Douglas-fir/ Pinegrass	Douglas-fir/ Snowberry	Douglas-fir	Douglas-fir/ Lodgepole Pine	Lodgepole Pine	Mix Subalpine	Subalpine Fir/ Elk Sedge	Mountain Big Sagebrush	Subalpine Fir/ Pinegrass	Grassland	Wyoming Big Sagebrush	Shrub Riparian	Douglas-fir/Arnica	Area (acres)
BLM	0.4	1.3		7.6	0.1	108.2	26.1	3.8	0.4		3.5	8.4	0.8	39.9	0.04		200.6
Forest Service			101.2	12.9	5.8	24.7				30.8	5.6						185.5
Private	15.8	21.2	25.0	13.5	12.1		4.7		0.02	3.7	11.4			1.6		1.9	110.9
TOTAL	**0.4**	**22.5**	**126.2**	**34.0**	**18.0**	**132.9**	**30.8**	**3.8**	**0.42**	**34.1**	**19.4**	**8.4**	**0.8**	**41.5**	**0.04**	**1.9**	**497.0**

[1] There would be no disturbance to subalpine fir/whitebark pine cover types; Jdx. = Jurisdiction.

Core reclamation would begin in 13 years whereas under Alternative M1 core reclamation would begin in 4 years. During reclamation trees would not be planted at the TSF (564 acres) (to minimize root penetration through the cap) (long-term, major effect). As described for Alternative M1, reclamation would initiate pioneer growth in primary succession which would gradually evolve to climax conifer shrubland and conifer forest. The initial revegetation would result in at least 70 percent of the ground cover found on adjacent reference areas. However, for decades (or 100 to 200 years for the conifer forests) there would be different vegetation patterns (e.g., early stage, fragmented communities) and lower vegetation productivity (long-term, moderate effects), and the area of the pit (~ 500 acres) would remain as rocky outcrop with a pit lake (long-term, moderate effects).

4.4.1.3. Alternative M3 – No Name Waste Rock Storage Facility

A total of 640.6 acres (29 % more than under Alternative M2) of primarily upland vegetation would be removed, primarily conifer forest (487.2 acres) and shrubland (105 acres) (short-term to long-term, major effect) (Table 4.4-2). There would be an increased probability of noxious weeds in the larger amount of disturbed areas, but the effect would be the same as for Alternative M2. There would be 27 percent more timber (3,169 mbf versus 2,548 mbf) harvested from a larger area (487.2 acres versus 391.0 acres) compared to under Alternative M2, but the effect would be the same as for Alternative M2.

Table 4.4-2. Vegetation disturbance, Alternative M3.

Jdx.[1]	Developed/ Disturbed	Barren/Rock	Douglas-fir/ Elk Sedge	Douglas-fir/ Pinegrass	Douglas-fir/ Snowberry	Douglas-fir	Douglas-fir/ Lodgepole Pine	Lodgepole Pine	Mix Subalpine	Subalpine Fir/ Elk Sedge	Mountain Big Sagebrush	Subalpine Fir/ Pinegrass	Grassland	Wyoming Big Sagebrush	Shrub Riparian	Douglas-fir/ Arnica	Area (acres)
BLM	0.16	18.8		7.6	0.11	189.6	78.6	21.8	2.8		18.3	8.4	1.7	70.0	0.2		418.1
Forest Service	0.01		55.8	10.6	5.8	24.7			0.4	23.3	5.6		4.5				130.7
Private	15.8	4.5	20.3	11.5	12.0	4.1	4.7		0.02	2.9	11.2	0.2	1.0	1.6		1.9	91.8
TOTAL	**0.16**	**23.3**	**76.1**	**29.7**	**17.9**	**218.4**	**83.3**	**21.8**	**3.2**	**26.2**	**35.1**	**8.6**	**7.2**	**71.6**	**0.2**	**1.9**	**640.6**

[1] There would be no disturbance to subalpine fir/whitebark pine cover types; Jdx. = Jurisdiction.

4.4.2. Land Disposal Alternatives

4.4.2.1. Alternative L1 – No Action

The condition of a narrow riparian corridor with sections of incised and trampled streambanks at the ranch would be improved due to recent riparian fencing, but further protection of the riparian area by better grazing strategies (BLM ranch management strategy) would not occur. Subparcel BWR-7 would not be rested from grazing (less residual vegetation). Compared to the surrounding Federal lands, there would probably be a similar probability of wildfire at the ranch, e.g., a higher probability of wildfire due to ranching activities, but a lower probability due to the irrigated land. The probability of developing noxious weeds at the Garden Creek property would be the same as for the surrounding Federal lands.

4.4.2.2. Alternative L2 – Proposed Land Exchange

There would be no effects to vegetation, forest resources, or invasive and non-native plants ("weeds") on the selected land (e.g., there is no sensitive plant species habitat at the selected land) except for the portion that includes the MMPO (Section 4.4.1). Approximately 2,500 feet of the S. Creek riparian corridor would leave Federal jurisdiction (Figure 2.2-1). A conservation easement would prohibit subdivision/residential development of the corridor. There would also be no effects to vegetation, forest resources, or weeds within the Thompson Creek corridor.

There would be a long-term increase in riparian vegetation at the ranch as the BLM ranch management strategies include restoration or protection of the shrub and forest corridor along Lyon Creek and the Salmon River. In particular, the lower 1,850 feet of Lyon Creek would have decreased sloughing and increased riparian vegetation per the Lyon Creek conceptual restoration plan (long-term, moderate effect). Approximately half of the ranch is considered potentially occupied by special status plants (i.e., the portion that is not cultivated agriculture) (Lemhi milkvetch and white eatonella occur at the ranch); this portion would receive extra protection for special status plant species and their habitat; i.e., under BLM jurisdiction management of special status plants would comply with BLM policy on special status plants (BLM Manual 6840 and supplement 6840.06 and Handbook H-6840-1) (long-term, minor effect). Public use of roads at the ranch would increase the probability of noxious weed development at the ranch (long-term, minor effect). The vegetation on portions of BWR-4, BWR-5, and BWR-6 would be affected by improvements such as a campground, interpretive site, or other recreational facility that would increase soil compaction, vegetation trampling, and noxious weed development (long-term, minor effect).

There would be a lower probability of noxious weed development in the Lyon Creek drainage under Alternative L2 (non-motorized access to the drainage) compared to Alternative L2-B (allows motorized access up the Lyon Creek drainage) (long-term, minor effect). There would continue to be livestock transport of weed seed on the ranch under Alternative L2, compared to no such transport on the areas of the ranch converted to native vegetation (~ half of the ranch) under Alternative L2-B. However, compared to Alternative L2 (cultivated fields), the converted area of the ranch (disturbed, relatively sparse vegetation) would be prone to weed infestation under Alternative L2-B in the long term, despite the BLM weed control program (negligible to moderate effect, depending on the success of the conversion to native vegetation). Under

Alternative L2-B all of the irrigated fields (portions of BWR-2 through BWR-7, 424 acres, 52 % of the ranch) would be converted to native vegetation (sagebrush steppe), which, compared to Alternative L2, would be a decrease of 95.4 percent in the agricultural land (currently 444.5 acres), and an increase of 123.0 percent of the sagebrush steppe (currently 9.5 acres of semi-desert grassland and 335.1 acres of semi-desert shrubland) (long-term, major effect). Not grazing the native vegetation would have little effect on the vegetation (e.g., Atwood et al. 1987; Holechek and Stephenson 1983; Hughes 1983; Pieper et al. 1993), and the vegetation communities would be expected to remain in mid- to late stage ecological succession with a static to upward ecological trend (negligible effect). However, as residual herbaceous and litter cover increases there would be a greater probability of wildfire at the ranch (negligible effect).

Federal acquisition of the Garden Creek property would allow better control of noxious weeds in the locality, and better protection of sensitive plant species and their habitat, e.g., there is suitable habitat for Idaho sedge along Garden Creek (long-term, minor effects).

4.4.2.3. Alternative L3 – Land Sale

The effects related to the selected land would be the same as under Alternative L2. The BLM would not administer the special status plant species or their habitat at the offered lands, and the BLM ranch management strategies would not be implemented. The effects to the offered lands would be the same as under Alternative L1.

4.4.2.4. Alternative L4 – Reduced Area Land Exchange, Fee Simple

The effects related to the selected land would be the same as under Alternative L2. Note that a shorter length (500 feet) of the S. Creek riparian corridor would leave Federal jurisdiction compared to Alternative L2 or Alternative L3 (2,500 feet) (Figure 2.2-1). The portion of the corridor leaving Federal jurisdiction could not be subdivided or developed residentially due to the Thompson Creek and S. Creek Conservation Easement. Regardless, no effects to the Thompson and Squaw Creek corridors are reasonably foreseeable apart from those due to the MMPO alternatives (negligible effects). The effects related to the offered lands would vary proportional to the lesser amount of offered lands acquired by the US.

4.4.2.5. Alternative L5 – Reduced Area Land Exchange, Easement

The vegetation on approximately 1,500 acres of the selected land would be protected by a conservation easement (Table 4.4-3). The S. Creek riparian corridor (2,500 feet in length) that would leave Federal jurisdiction could not be subdivided or developed residentially due to the Thompson Creek and S. Creek Conservation Easement. However, there would be no disturbance to the vegetation in the corridor in the foreseeable future (negligible effects). The effects related to the offered lands would be similar to those under Alternative L4, except slightly more (by fair market value) of the offered lands would be acquired by the US (long-term, minor effect).

Table 4.4-3. Vegetation protected by conservation easement, Alt. L5.

Vegetation Cover Type/ Plant Community	(acres)[1]
GRASSLAND	
Grasslands	40.0
SEMI-DESERT SHRUBLAND	
Mountain Big Sagebrush	211.6
Mountain Mahogany	5.0
Wyoming Big Sagebrush	85.6
MESIC SHRUBLAND	
Shrub-dominated Riparian	39.0
FOREST	
Deciduous Forest Riparian	7.6
EVERGREEN FOREST	
Douglas-fir	30.1
Douglas-fir/Pinegrass	255.7
Douglas-fir/Snowberry	634.4
Lodgepole Pine	7.2
Mixed Subalpine	170.2
Subalpine Fir	10.7
Subalpine Fir/Lodgepole Pine	19.5
TOTAL	**1,516.6**

[1] Areas do not include barren/rock or currently disturbed/road areas.

4.5. Range Resources

4.5.1. MMPO Alternatives

4.5.1.1. Alternative M1 – No Action

There would be no changes to the areas or AUMs available for grazing in any BLM allotments (Table 4.5-1., current area).

4.5.1.2. Alternative M2 – MMPO as Submitted by TCMC

There would be 172 acres of disturbance from the expansion of the Pat Hughes WRSF in the Thompson Creek Allotment. The S. Creek Allotment would not be affected (Table 4.5-1).

Table 4.5-1. Changes in grazing allotments and pastures, Alternative M2.

BLM Allotment (bold) and Pasture	Current Area (acres)	Area Decrease (acres)	Decrease (%)	Decrease (AUM)
S. Creek – Redbird	3,031	0	0	0
S. Creek – Saturday Mtn.	3,073	0	0	0
S. Creek – South Butte	3,383	0	0	0
S. Creek TOTAL	**9,487**	**0**	**0**	**0**
Thompson Creek – Lower	1,918	0	0	0
Thompson Creek – Unit 2	5,056	172	3.4	2
Thompson Creek TOTAL	**6,974**	**172**	**2.5**	**2**

Most of the land in the Thompson Creek Allotment is too steep and/or rocky to provide forage for livestock (i.e., ≤ 1 AUM/19.4 acres). Based on an analysis of NRCS Ecological Site data for the area (NRCS 2007), there would be 39 acres (2 AUMS) of reasonably productive, loamy, sagebrush-grasslands in the MMPO area. There would be 991 acres of similar land (51 AUMs) in the allotment. Construction of the Pat Hughes WRSF would thus eliminate 2 AUMs, or 4 percent of the AUMs used for livestock grazing in the Thompson Creek Allotment for a period of more than 10 years (negligible effect). This decrease would probably displace cattle from upland areas and increase grazing pressure along Thompson Creek (long-term, minor effect). The WRSFs would eventually be reclaimed, but vegetation growth would be relatively slow at the relatively high elevation of the mine (CNAP 1998); it would be a number of years before the reclaimed surface of the WRSFs would provide adequate forage for livestock or wildlife.

4.5.1.3. Alternative M3 – No Name Waste Rock Storage Facility

There would be no decrease in the land available for grazing in the S. Creek Allotment. The No Name WRSF would be on a south-facing slope in rocky terrain above Thompson Creek. The No Name and Pat Hughes WRSFs would disturb 128 acres and 150 acres, respectively, in the Thompson Creek Allotment. Other mining would disturb 3.6 acres in the Thompson Creek drainage, for a total decrease of 282 acres (3 AUMS, 6 %) available for grazing in the allotment (Table 4.5-2.) (long-term, negligible and minor effects).

Table 4.5-2. Changes in grazing allotments and pastures, Alternative M3.

BLM Allotment (bold) and Pasture	Current Area (acres)	Area Decrease (acres)	Decrease (%)	Decrease (AUM)
S. Creek – Redbird	3,031	0	0	0
S. Creek – Saturday Mtn.	3,073	0	0	0
S. Creek – South Butte	3,383	0	0	0
S. Creek TOTAL	**9,487**	**0**	**0**	**0**
Thompson Creek – Lower	1,918	0	0	0
Thompson Creek – Unit 2	5,066	282	5.6	3
Thompson Creek TOTAL	**6,974**	**282**	**4.0**	**3**

4.5.2. Land Disposal Alternatives

4.5.2.1. Alternative L1 – No Action

There would be no changes to the areas and AUMs available for grazing in any BLM allotments (Table 4.5-3., current area), or to the current grazing practices.

4.5.2.2. Alternative L2 – Land Exchange Proposal

Regarding the selected land, the BLM would dispose of 75 acres in the Redbird pasture and 123 acres in the Saturday Mountain pasture, or 198 acres (2.1 %) of the S. Creek Allotment (Table 4.5-3). Cattle graze these pastures while trailing north on S. Creek Road to higher elevation areas to the north and east. Cattle would not be able to access the riparian zone adjacent to S. Creek. However, there is no authorized grazing on the portion of the allotment that would be disposed of due to the steep and rugged terrain (BLM 2010a) (no effect). The BLM would receive administrative access (which would include BLM permittees) to use roads on property owned by TCMC to access the Saturday Mountain Pasture, including approximately 2,500 acres of Federal and State lands (long-term, major effect).

Table 4.5-3. Changes in grazing allotments and pastures, Alternative L2.

BLM Allotment (bold) or Pasture	Current Area (acres)	Area Decrease (acres)	Decrease (%)	Decrease (AUM)
S. Creek – Redbird	3,031	75	2.5	0
S. Creek – Saturday Mtn.	3,073	123	4.0	0
S. Creek – South Butte	3,383	0	0.0	0
S. Creek TOTAL	**9,487**	**198**	**2.1**	**0**
Thompson Creek – Lower	1,918	616	32.1	22
Thompson Creek – Unit 2	5,056	1,356	26.8	19
Thompson Creek TOTAL	**6,974**	**1,972**	**28.3**	**41**

There would be a decrease of 616 acres in the Lower pasture and 1,356 acres in the Unit 2 pasture, or 1,972 acres (28 %) of the Thompson Creek Allotment. The decreased area in the Lower pasture would contain 430 acres suitable for grazing (22 AUMs). The decreased area in the Unit 2 pasture would contain 362 acres suitable for grazing (19 AUMs). Therefore, 792 of 991 acres (80 %) suitable for grazing and 41 of 51 AUMS (80 %) would not be available for grazing (long-term, major effect). Such a large decrease would change the overall distribution of cattle in the allotment, with cattle more likely to congregate along Thompson Creek (the primary source of the remaining 10 AUMs). It would not be economically feasible for a livestock operator to graze cattle on the Thompson Creek Allotment because of the resources needed to meet resource objectives for Thompson Creek. Therefore, grazing would not be authorized for any of the AUMs in the Thompson Creek Allotment (long-term, major effect). In addition, the Thompson Creek and S. Creek Conservation Easement would not allow grazing (10 AUMs) within the Thompson Creek riparian corridor (long-term, minor effect to range resources that would be acquired by TCMC).

The BLM would authorize approximately 2,400 AUMs (~ 120 AUMs less when BWR-7 would be rested) on the irrigated land at the Broken Wing Ranch, which is the current amount of use on the ranch. In addition, the unfenced rangeland at the ranch would continue to be grazed as part of the adjacent BLM allotments (negligible effects to range resources but a long-term, minor effect to the sizes of the allotments) (Section 4.12.2.2). A few small areas of the ranch may not be irrigated, e.g., an area developed as a campground. Subparcel BWR-7 (no hay production) would be rested at times from grazing and managed with a focus on weed eradication. During such times there would be a temporary reduction of 120 AUMs (5 % of the total AUMs) (short-term, minor effect). There would be an increase in the number of vehicles and people at the ranch, which would disturb the relatively confined cattle, especially from proximal firearm discharge. There would also probably be some conflicts between public use of the ranch and the agricultural/grazing activities, e.g., gates not properly opened or closed, damage to crops, etc. (long-term, minor or moderate effects).

Under Alternative L2-B range resources would be not utilized at the ranch, which would mean 2,400 AUMs would need to be utilized elsewhere (long-term, major effect).

The Garden Creek property, because it is not fenced, would continue to be grazed when the adjacent Federal allotments are grazed (no effect). In the long term the BLM would probably inventory the property, conduct a land health assessment, determine the available grazing resources, and establish the available AUMs, the stocking rate, and the kind and class of livestock. Such would probably (administratively) increase the available AUMs of the Old Tom Allotment from 473 to 545 AUMs (15 %) (no effect to range resources but a long-term, moderate effect to the size of the allotment) (Section 4.12.2.2).

4.5.2.3. Alternative L3 – Land Sale

The same effects for the selected land would be the same as under Alternative L2, unless the land was sold to a party other than TCMC. In such case the BLM would not obtain a grant from TCMC to the BLM for administrative access (including BLM permittees) to use roads on private property owned by TCMC to reach the Saturday Mountain pasture (long-term, major effect). The range resources of the offered lands would not come under BLM administration (long-term, moderate effect).

4.5.2.4. Alternative L4 – Reduced Area Land Exchange, Fee Simple

Compared to Alternative L1, there would be decreases in the areas of the S. Creek Allotment (3 acres) and Thompson Creek Allotment (1,878 acres). The decreased area in the Lower pasture would contain 344 acres suitable for grazing (17 AUMs), and the decreased area in the Unit 2 pasture would contain 362 acres suitable for grazing (19 AUMs). Therefore, 706 of 991 acres (71 %) suitable for grazing and 36 of 51 AUMS (69 %) would not be available for grazing (long-term, major effect) (Table 4.5-4). Compared to Alternative L2, there would be less range resources that would come under BLM administration as portions of the ranch and/or Garden Creek property would not be acquired by the US (long-term, minor effect).

Table 4.5-4. Changes in grazing allotments and pastures, Alternative L4.

BLM Allotments (bold) and Pastures	Current Area (acres)	Area Decrease (acres)	Decrease (%)	Decrease (AUM)
S. Creek – Redbird	3,031	2	< 1	0
S. Creek – Saturday Mtn.	3,073	1	< 1	0
S. Creek – South Butte	3,383	0	0	0
S. Creek TOTAL	**9,487**	**3**	**< 1**	**0**
Thompson Creek – Lower	1,918	522	27.2	17
Thompson Creek – Unit 2	5,056	1,356	26.8	19
Thompson Creek TOTAL	**6,974**	**1,878**	**26.9**	**36**

4.5.2.5. Alternative L5 – Reduced Area Land Exchange, Easement

The effects related to the selected land would be the same as for Alternative L2 (long-term, major effects) (Table 4.5-3). The effects related to the offered lands would be the same as for Alternative L4, but slightly more offered lands would come under BLM administration.

4.6. Water Resources

4.6.1. MMPO Alternatives

4.6.1.1. Alternative M1 – No Action

Surface Water

The quantity and/or the quality of surface water may be affected by the project compared to current conditions. The effects to quantity can be either a reduction in flow or contribution to flow (e.g., capturing groundwater using cutoff walls) or an increase in flow (e.g., ceasing to withdraw water for mining). The effects to quality are primarily evaluated during low flow when there is relatively low dilution capacity. Water quality during high flow is also discussed. Only the concentrations of constituents that are known to be elevated in the various mine waters are discussed in detail in the FEIS. The future effects described in this section are based on monitoring data, and supported by the results of an extensive study conducted by TCMC's consultants, which included climate, hydrologic, mine waste, and geologic characterizations; numerical calculations from geochemical and hydrogeological modeling; pit lake modeling; water balance development considering the planned water management; and use of receiving stream/mine water mixing calculations. The models used in the assessment were empirically derived and therefore provide a relatively high degree of confidence in support of the overall assessment.

The effects to water quality (chemistry) during baseflow conditions were evaluated under various conservative assumptions. In cases where *best* estimates and *upper* estimates were calculated, the best estimates are considered the reasonably foreseeable values whereas the upper estimates are the maximum plausible/worst-case values. The effects are summarized below from two regulatory aspects: 1) whether the water quality would meet relevant beneficial use criteria established by the WQSs; and 2) whether the water quality would likely comply[3] with antidegradation policy that is part of the WQSs (Section 3.6.1.1). Under the antidegradation rule, a stream with water quality better than the minimum quality set by the beneficial use criteria may be managed to maintain the current quality unless degradation is allowed following a public review of social and economic tradeoffs. In the case of Alternative M1 (No Action), predicted incidents of problematic water quality are isolated, infrequent, and only occur under the most conservative scenarios. Also note that the frequency of low-frequency events such as extreme floods or the probabilistic 7Q10 flow (lowest 7 day flow that is likely to occur on average once every 10 years) is inherently uncertain.

[3] It is not possible to determine exactly by what means IDEQ would perform the antidegradation analysis. The FEIS performs a proxy analysis using the existing data statistics and IDEQ guidance; neither may ultimately be used by IDEQ. Thus, the FEIS analysis should only be used for comparative purposes between alternatives. Actual antidegradation calculations performed by IDEQ could result in better or worse conditions than predicted here.

During mining and after reclamation a number of structures would continue to hold and/or convey stormwater and/or other mine water. These structures are/would be designed to manage at least the 100 year/24 hour, 500 year/24 hour, or, in the case of the TSF, the probable maximum flood (Section 2.1.1.6., Section 2.1.1.8., Section 2.1.3.6., Section 2.1.4.8., Section 3.6.1.1). Of these structures, the two Bruno Creek sedimentation ponds – designed for the 100 year/24 hour storm – would have the greatest potential for the uncontrolled release of water during extreme flood events (until the ponds would be removed when berms along the Bruno Creek Road would no longer be required by the MSHA). The drainage intercepted by these sediment ponds is largely controlled by the TSF, which is designed to contain the probable maximum flood. The incremental effect on these ponds is therefore relatively small. However, any uncontrolled release of water from these facilities would be managed as it currently is, with the same effect to water quantity or quality (likely negligible due to dilution in receiving streams that are also likely to be experiencing high flows, with no resultant exceedance in WQSs).

Water quality effects at the mine would in part arise from ARD. However, where it would occur, it would in large part be controlled with the water management system. In general, the Pat Hughes WRSF began producing ARD in the mid-2000s. The Buckskin WRSF does not produce ARD, but some pockets of Type 2 waste rock in the facility could eventually produce ARD. The TSF has different ARD characteristics for the impoundment and the embankment: there is no potential for ARD in the tailings slimes and sands within the impoundment due to saturated and anoxic storage conditions, but the embankment sands may become acid generating in the future. Effects to water quantity (Figure 4.6-1.) are limited to collection of groundwater associated with the implementation of groundwater cutoff (vertical slurry) walls (Figure 4.6-2., Figure 4.6-3). Effects to water quality are limited to the very small portion of groundwater that may bypass groundwater cutoff (vertical slurry) walls (Section 4.6.1.1.2). The effects to water resources related to the Buckskin and Pat Hughes WRSFs do not consider capping during reclamation, as described for Alternative M1 or Alternative M2 (Section 2.4.1.8.), as capping is not expected to alter the behavior of affected seepage and performance of cutoff walls within the groundwater systems below these facilities.

Thompson Creek and Tributaries

Low-flow Conditions

The effects to surface water under Alternative M1 would be the net effects of the groundwater cutoff walls and other water management practices. The cutoff walls would reduce the flow in Thompson Creek (long-term, negligible or minor effect), but would be expected to prevent the majority of WRSF constituent loadings (loadings equate to the product of concentration and flow) from reaching Thompson Creek, as described further below. A mass loading approach was used to conduct a sensitivity analysis of effects on Thompson Creek water quality. The sensitivity analysis approach is described below and included a range of concentrations of constituents in seepage water from the WRSFs (best and upper estimates), groundwater flow rates bypassing the cutoff walls, and low-flow conditions in Thompson Creek.

Source	Description	Flow Estimates best	upper
a	Buckskin cutoff seepage - colluvium (gpm)	0.002	0.166
	Buckskin metasediment groundwater (gpm)	1.59	1.59
b	Pat Hughes cutoff seepage - colluvium (gpm)	0.005	0.38
	Pat Hughes metasediment groundwater (gpm)	11.1	11.1
c	Seepage via Redbird (gpm)*	35	35
d	Seepage via Bruno (gpm)**	3.9	8.0
e	Treated water (cfs) via outfall 005 after year 30	2.04	2.04

*only during years 1-5 ** during years 6-plus

Receiving stream **annual low flows,** *7q10*

Internal sources with no direct discharge

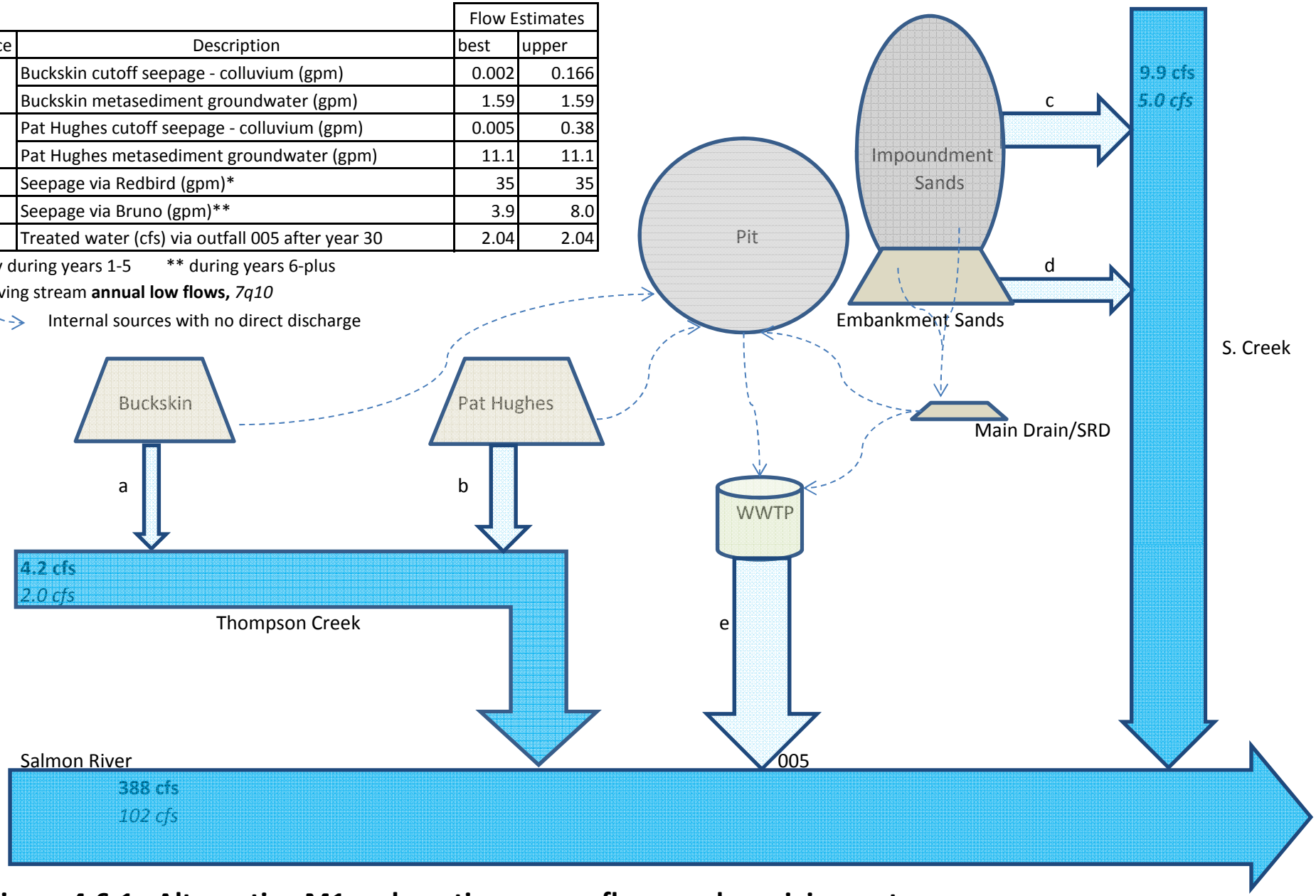


Figure 4.6-1. Alternative M1 reclamation source flows and receiving waters.

Flow Arrow	Description			Average (gpm)	Range (gpm)	
					Min	Max
a	Buckskin to Lime Plant	Best Estimate		54	0	361
		Upper Estimate		169	55	934
b	Pat Hughes to Lime Plant	Best Estimate		125	64	581
		Upper Estimate		125	64	581
c	Lime Plant to Pit	Best Estimate	high flow	110	0	486
			low flow	70	0	581
		Upper Estimate	high flow	295	123	1,414
			low flow	0	0	0
d	Runoff to Pit			23	6	201
e	Main Drain Seepage			739	456	1,385
f	Discharge to WWTP			0	0	0

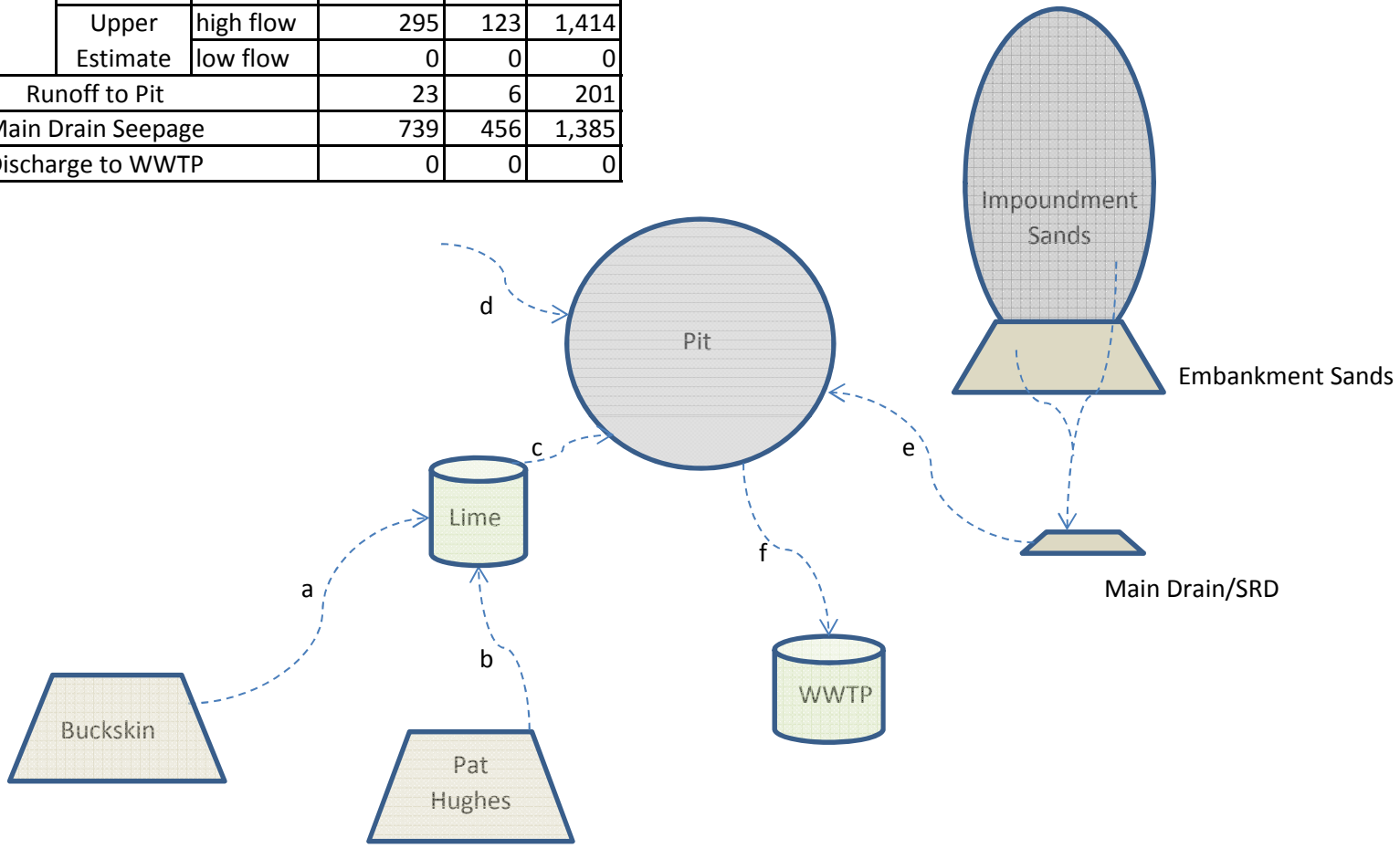


Figure 4.6-2. Alternative M1 water management, years 1-5.

Flow Arrow	Description			Average (gpm)	Range (gpm)	
					Min	Max
a	Buckskin to Lime Plant	Best Estimate		52	0	406
		Upper Estimate		224	45	1,580
b	Pat Hughes to Lime Plant	Best Estimate		217	54	1,532
		Upper Estimate		217	54	1,532
c	Lime Plant to Pit	Best Estimate	high flow	115	0	1,082
			low flow	141	0	1,532
		Upper Estimate	high flow	423	104	3,099
			low flow	0	0	0
d	Runoff to Pit			80	5	1,566
e	Main Drain Seepage to WWTP			145	---	
f	Pit Discharge to WWTP from year 31			636	0	11,938

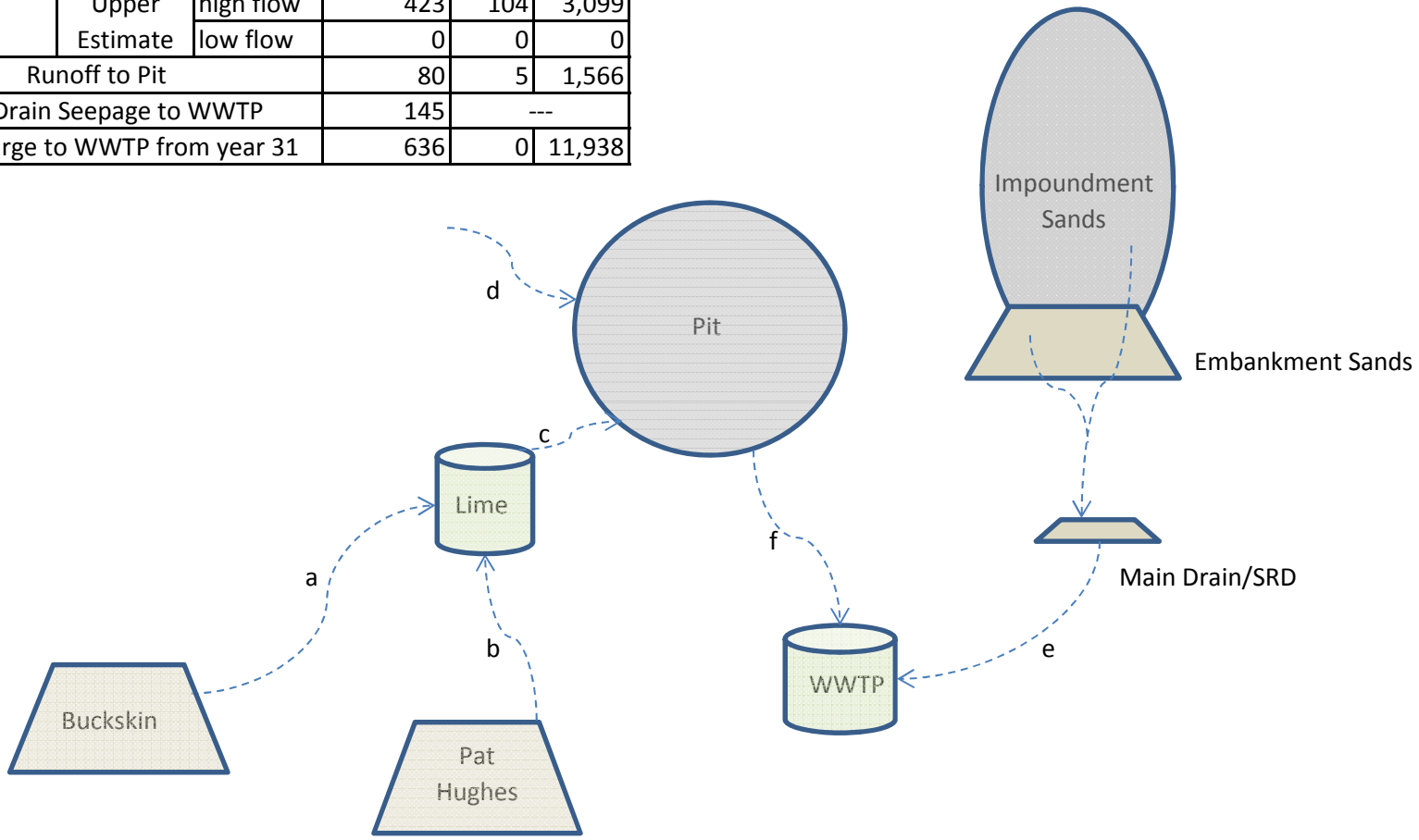


Figure 4.6-3. Alternative M1 water management, years 6-plus.

The loading scenarios include a best estimate and an upper estimate of loads to groundwater based on the concentrations of constituents in seepage from the WRSFs. The best estimate is based on the following assumptions: 1) the current chemistry of the seepage water from the Buckskin WRSF is at steady-state condition (would not change over time); 2) the chemistry of the seepage water from the Pat Hughes WRSF would be a mixture of a conservatively chosen Pat Hughes pore water with pH 3.5 and non-mine-affected groundwater, but with the ratio of Pat Hughes pore water increased relative to groundwater to reflect the increase in the area of the WRSF for each alternative; 3) the mixed water would have pH 4.5 and concentrations of constituents similar to current concentrations measured at PHtoe; and 4) leakage through the cutoff wall would be the expected flow based on statistical analysis of hydraulic conductivities of the cutoff wall and underlying bedrock.

The upper estimate is based on the following assumptions: 1) seepage from the Buckskin WRSF would become acidic; 2) water quality of the Pat Hughes WRSF seepage would be equal to that of the Pat Hughes pore water (pH 3.5) with no groundwater dilution; and 3) leakage through the cutoff wall would be greater than under the best estimate.

Two Thompson Creek streamflow scenarios were assessed under each of the loading scenarios. The first scenario (Table 4.6-1.) is for an average annual low flow ("low flow") of 4.2 cfs (from average flows in January at the Thompson Creek USGS station during 1973 to 2009). The second scenario (Table 4.6-2.) is for the 7Q10 flow of 2.0 cfs. Both of these scenarios use the same water quality for the receiving water (Thompson Creek), i.e., the 95th percentile of background water quality from a 10 year record at TC4 during only months of low flow (Table 4.6-1). The assumed hardness (important for determining the appropriate regulatory criteria for certain metals) is 47 mg/L, the median hardness for the months of low flow in the data at TC4.

Table 4.6-1. Thompson Creek water quality, low flow, Alternative M1.
all units are µg/L except mg/L for SO_4^{2-}

Parameter[1]	Existing Thompson Creek Receiving Water Quality	Predicted Thompson Creek Water Quality		CMC[2]	CCC[2]
		Best Estimate	Upper Estimate		
SO_4^{2-}	14	15.7	16.3	N/A	N/A
Al	8.8	8.9	29.9	N/A	N/A
As	0.5	0.5	0.5	340	150
Cd	0.05	0.05	0.07	0.71	0.37
Co	0.1	0.10	0.57	N/A	N/A
Cu	0.8	0.81	1.54	8.4	6.0
Fe	30	30	30	N/A	N/A
Pb	0.075	0.08	0.10	28	1.1
Mn	0.48	0.5	24.3	N/A	N/A
Mo	2.07	2.1	2.1	N/A	N/A
Ni	0.46	0.5	0.5	247	27
Se-T	1.95	2.0	2.0	20	5
U	1	1.0	1.2	N/A	N/A
Zn	3	3.0	5.1	62	62

[1] Dissolved metal data were used for all metals except selenium, since the selenium guideline applies to the concentration of total selenium.
[2] CMC/CCC standards assuming a hardness of 47 mg/L

Table 4.6-2. Thompson Creek water quality, 7Q10 flow, Alternative M1.
all units are µg/L except mg/L for SO_4^{2-}

Parameter[1]	Existing Thompson Creek Receiving Water Quality	Predicted Thompson Creek Water Quality		CMC[2]	CCC[2]
		Best Estimate	Upper Estimate		
SO_4^{2-}	14	17.4	18.8	N/A	N/A
Al	8.8	9.1	53.1	N/A	N/A
As	0.5	0.5	0.5	340	150
Cd	0.05	0.05	0.10	0.71	0.37
Co	0.1	0.10	1.08	N/A	N/A
Cu	0.8	0.81	2.35	8.4	6.0
Fe	30	30.1	31	N/A	N/A
Pb	0.075	0.08	0.12	28	1.1
Mn	0.48	0.6	50.5	N/A	N/A
Mo	2.07	2.2	2.2	N/A	N/A
Ni	0.46	0.5	0.5	247	27
Se-T	1.95	2.0	2.0	20	5
U	1	1.0	1.4	N/A	N/A
Zn	3	3.0	7.4	62	62

[1] Dissolved metal data were used for all metals except selenium, since the selenium guideline applies to the concentration of total selenium.
[2] CMC/CCC standards assuming a hardness of 52 mg/L

Under all analyzed scenarios, the water quality of Thompson Creek would meet all numeric WQSs. Of the constituents evaluated for antidegradation considerations, all would be under the 10 percent threshold (the assimilative capacity – a concentration 10 % greater than the 95th percentile of the current concentration) under all analyzed scenarios except for the low flow/upper estimate – copper, and the 7Q10 flow/upper estimate – copper and cadmium. These exceptions would be categorized as *significant degradation* under this analysis (in the context of IDEQ regulations and not NEPA analysis).

<u>High-flow Conditions</u>

NPDES Outfall 001 and Outfall 002 would continue to be used when the flow and chemistry of the discharged water would meet the NPDES permit conditions. When water does not meet these conditions, it would be retained on site and/or discharged at Outfall 005 after treatment. In some instances, however, there would still be the potential for permit limit exceedances at these

outfalls during spring run-off (long-term, infrequent, minor effect). These isolated exceedances would most likely be related to TSS and would not be expected to have any more than a very short-term, minor effect on Thompson Creek water quality.

S. Creek and Tributaries

There would be negligible changes to the flows of Bruno Creek or Redbird Creek during mining. After milling is completed, water in upper Bruno Creek would no longer be collected for processing, and would flow more consistently into lower Bruno Creek below the TSF embankment, increasing streamflow. However, the variations in flow in lower Bruno Creek would generally be within the range of the current variations. Redbird Creek would have reduced flow when the seepage to the stream from the TSF decreases (long-term, minor effects). Neither of these effects would cause more than a negligible effect to the flow of S. Creek. TCMC has water rights to use 6.3 cfs from S. Creek for irrigation, but it is unknown how much of this right is used each year (except that the water can be diverted only during high flow). It is assumed that such water would be diverted for the foreseeable future.

Low-flow Conditions

The water quality of S. Creek, which includes some seepage from the TSF, and the water quality of Bruno Creek would be the same throughout mining. The sulfate and chloride loads to Redbird Creek from the TSF would continue during mining, but would have negligible effects to S. Creek. There is not sufficient data to evaluate in detail the effect of the TSF on the water quality of Redbird Creek. However, there would likely be varying degrees of degradation depending on the constituent. Considering that the average annual low flow and the 7Q10 flow in Redbird Creek might be two orders of magnitude lower than in Squaw Creek, Redbird Creek would have much less ability to dilute metal loads from the TSF. The concentration of sulfate, e.g., might be an order of magnitude greater at the mouth of Redbird Creek than that predicted in S. Creek (best estimate, average annual low flow during Phase 8). In contrast, the concentration of copper, which does not appear to elevated in the TSF water, might be similar in both Redbird Creek and S. Creek. After reclamation the TSF would gradually dewater with reduced seepage into groundwater, reducing or eliminating the sulfate and chloride loads to Redbird Creek. The TSF has been designed so that the tailings slimes are not expected to oxidize. They have ample alkalinity to prevent the formation of acidic mine drainage within the impoundment. The acidic seepage predicted to occur from the TSF embankment (as opposed to from the impoundment) would not affect the water quality of Redbird Creek as the embankment is not hydraulically connected to Redbird Creek. Seepage from the embankment would be captured by the pumpback system below the SRD and is not expected to affect Bruno Creek.

The water quality of S. Creek was evaluated in the same manner as for Thompson Creek, with an annual average low flow of 9.9 cfs (from average flows in January at the S. Creek USGS station during 1973 to 2009) and an estimated 7Q10 flow of 5.0 cfs. There is no water quality data for S. Creek upstream of Redbird Creek to establish background conditions. Therefore, the background water quality of the receiving water (S. Creek) was set as the 95th percentile of the 10 year record of water quality from the months of low flow at the downstream S. Creek site (SQ2) (that includes loads from Bruno Creek and Redbird Creek) (Table 4.6-3). Therefore, the

concentrations of constituents in the water quality predictions would probably be overestimated as the loads would potentially be double-counted.

Loads to S. Creek would be from only potential seepage from the TSF embankment. As a conservative assumption the embankment is predicted to become acid generating after reclamation in the long term. The conservative effects analysis assumed that some portion of the embankment seepage would enter S. Creek via Bruno Creek. Following tailings consolidation, seepage to Redbird Creek from the impoundment would be negligible. As a result, loadings to S. Creek via Redbird Creek would be negligible in the long term.

The best-estimate scenario is based on the following assumptions: 1) the chemistry of the impoundment seepage water entering Redbird Creek is that of the median concentrations of constituents in water from the main drain in 2010; 2) the amount of seepage entering Redbird Creek would be the predicted amount of seepage from the impoundment; 3) the seepage to Bruno Creek is seepage from embankment sands that have become acid generating and are not diluted; and 4) the seepage flow to Bruno Creek is based on hydraulic conductivities and gradients of groundwater flows derived from monitoring well data. The upper-estimate scenario is based on the same assumptions as for the best-estimate scenario except: 1) the chemistry of the seepage water entering Redbird Creek is that of the maximum concentrations of constituents in water from the main drain in 2010, and 2) the seepage flow to Bruno Creek is twice that of the best estimate.

In addition, the water quality of S. Creek was evaluated for the first 5 years after mining and milling is completed, when tailings consolidation seepage flows would be delivered to the pit (Table 4.6-3.) and for the years after that when tailings consolidation is complete (Table 4.6-4). For Years 6-plus the calculations were made with the highly conservative assumption that some seepage from the TSF would escape or bypass the water management system (i.e., Bruno Creek would receive seepage from the TSF that bypasses the SRD), even though such is not believed to occur now and would not be expected to occur in the future. The loads to Redbird Creek would occur only during Years 1 to 5 and the loads to Bruno Creek would occur only during Years 6-plus.

There would be no exceedances of numeric WQSs for S. Creek except under the Years 6-plus, conservative 7Q10 flow/upper estimate for which the concentration of cadmium (1.11 µg/L) would be slightly greater than the CCC (0.74 µg/L) (long-term, infrequent, moderate or major effect). Should such exceedance occur, the IDEQ would require appropriate studies to better document the effects to water quality/water resources, and, if necessary, prescribe remedial actions. In situations like this, isolated instances of instream water quality exceeding a numeric WQS, in and of themselves, may not be considered a violation of State law.

Regarding antidegradation, the concentrations of all considered constituents would be under the 10 percent threshold (*insignificant degradation* in the context of IDEQ regulations) for S. Creek under all Year 1 to 5 scenarios. The concentrations would be greater than the threshold for all Years 6-plus scenarios: low flow/best estimate – copper and cadmium; low flow/upper estimate – copper, cadmium, and zinc; 7Q10 flow/best estimate – copper, cadmium, and zinc; and 7Q10/flow upper estimate – copper, cadmium, zinc, and nickel (long-term, infrequent, minor effects).

Table 4.6-3. S. Creek water quality, Years 1-5, Alternative M1.
all units are µg/L except mg/L for SO_4^{2-}

Parameter[1]	Existing S. Creek Receiving Water Quality	Predicted S. Creek Water Quality Low Flow		Predicted S. Creek Water Quality 7Q10 Flow		CMC[2]	CCC[2]
		Best Estimate	Upper Estimate	Best Estimate	Upper Estimate		
SO_4^{2-}	75	85	86	94	96	N/A	N/A
Al	26	26	26	26	26	N/A	N/A
As	0.96	0.98	1.00	0.99	1.04	340	150
Cd	0.05	0.05	0.05	0.05	0.05	1.96	0.74
Co	0.14	0.18	0.18	0.21	0.22	N/A	N/A
Cu	0.53	0.53	0.57	0.53	0.61	26	16.7
Fe	30	50	60	70	90	N/A	N/A
Pb	0.1	0.10	0.10	0.10	0.10	105	4.1
Mn	2.5	41	42	79	81	N/A	N/A
Mo	2.8	2.8	2.8	2.8	2.8	N/A	N/A
Ni	1.3	1.4	1.4	1.5	1.5	686	76
Se-T	1	1.0	1.0	1.0	1.0	20	5
U	1	1.0	1.1	1.1	1.1	N/A	N/A
Zn	2.5	2.5	2.6	2.6	2.7	172	173

[1] Dissolved metal data were used for all metals except selenium, since the selenium guideline applies to the concentration of total selenium.
[2] CMC/CCC standards assuming a hardness of 157 mg/L

Table 4.6-4. S. Creek water quality, Years 6-plus, Alternative M1.
all units are µg/L except mg/L for SO_4^{2-}

Parameter[1]	Existing S. Creek Receiving Water Quality	Predicted S. Creek Water Quality Low Flow		Predicted S. Creek Water Quality 7Q10 Flow		CMC[2]	CCC[2]
		Best Estimate	Upper Estimate	Best Estimate	Upper Estimate		
SO_4^{2-}	75	77	79	79	82	N/A	N/A
Al	26	40	54	54	82	N/A	N/A
As	0.96	0.98	1.00	1.00	1.03	340	150
Cd	0.05	0.32	0.59	0.58	1.11	1.96	0.74
Co	0.14	0.53	0.92	0.92	1.70	N/A	N/A
Cu	0.53	2.22	3.92	3.89	7.25	26	16.7
Fe	30	31	32	32	33	N/A	N/A
Pb	0.1	0.19	0.28	0.28	0.46	105	4.1
Mn	2.5	25	47	47	91	N/A	N/A
Mo	2.8	2.8	2.8	2.8	2.8	N/A	N/A
Ni	1.3	3.2	5.1	5.1	8.8	686	76
Se-T	1	1.0	1.0	1.0	1.0	20	20/5
U	1	2.0	3.0	2.9	4.9	N/A	N/A
Zn	2.5	14.1	25.7	25.5	48.5	172	173

[1] Dissolved metal data were used for all metals except selenium, since the selenium guideline applies to the concentration of total selenium.
[2] CMC/CCC standards assuming a hardness of 157 mg/L

High-flow Conditions

The TSS and turbidity in S. Creek would be the same as present. During reclamation, despite erosion and sediment controls, there would be increased potential during storm events for sediment delivery to S. Creek from large areas of construction activities (e.g., the TSF) (short-term, minor effect; long-term negligible effect). However this sediment delivery is not likely to cause exceedances of WQS.

Salmon River

The rates of dewatering the open pit during mining would increase from 300 gpm to 358 gpm, a negligible effect because the additional water would reduce the amount of make-up water taken from other sources. After reclamation or during interim management there would no longer be make-up water withdrawn from the Salmon River for the mill (up to 4.5 cfs utilized out of a

20.89 cfs water right). Not removing this quantity of water from the Salmon River during low flow such as the 7Q10 flow (103 cfs) would be a long-term, minor effect. During average and high flow not removing such water would be a negligible effect.

After reclamation the pit dewatering would cease and the pit would be used to store water collected by the water management system, e.g., water from the TSF main drain and, most importantly from a volume perspective, treated water (via an initial lime treatment plan to ensure the pH in the flooded pit remains neutral) from both WRSFs. A pit lake would gradually develop, with the water surface reaching an elevation of 7,030 feet in approximately 30 years. At that time, water would be pumped from the lake to avoid seepage via an early 1970s exploration tunnel that intersected the pit wall at an elevation of 7,040 feet (the tunnel has been sealed but TCMC wants to ensure uncontrolled seepage does not occur). The lake would be a permanent open water feature, but would not function ecologically as it would be maintained as a managed water facility (Table 4.6-5.) (long-term effect that is necessary to ensure that WQS in receiving streams will be met).

Table 4.6-5. Final pit lake water chemistry (complete mixing).
all units are µg/L except mg/L for SO_4^{2-}

Parameter	Alternative M1	Alternative M2
SO_4^{2-}	1,200	1,100
As	5.2	3.5
Cd (III/IV)	12	8.5
Cu	160	99
Fe	390	290
Mn	7,300	5,500
Mo	400	250
Ni	19	13
Pb	10	7.4
Se-T	20	20
Zn	730	450

Water pumped from the lake would be treated in a second treatment plant (lime neutralization/clarification/filtration), similar to the current PWTP, and would be suitable for discharge to the Salmon River via NPDES Outfall 005 (Table 4.6-6). Seepage from the SRD would be sent to the second treatment plant. The plant would discharge at an estimated average rate of 914 gpm (2.04 cfs), which would be 0.5 percent of the average annual low flow in the Salmon River during the winter months (388 cfs) (Section 3.6.) (negligible effect). The current NPDES permit does not specify a limit on a discharge rate for Outfall 005, but instead specifies dilution ratios that must be achieved in the Salmon River. When the river flows are 2,000 cfs or less, the ratio must be greater than or equal to 120, a value derived in part from the IDEQ mixing

model (IDEQ 2000). The dilution ratio would be achieved under normal winter low flow (400 cfs), but would not be met for the 7Q10 flow (103 cfs). During these low flow periods, if at all possible, water would be stored in the pit and would not be discharged to the Salmon River as necessary to comply with receiving water standards. However, during extreme periods of low flow the discharge would likely be matched to the Salmon River hydrograph to comply with the dilution ratio. Regardless, the discharge rate of 2.04 cfs would be a negligible effect to the flow of the Salmon River even during the 7Q10 flow.

Table 4.6-6. NPDES Outfall 005 water quality.
all units are µg/L except mg/L for SO_4^{2-} and s.u. for pH

Parameter	Alternative M1
pH	8.7
SO_4^{2-}	1,150
Al	2,150
As	< 0.1
Cd	0.8
Co	6.4
Cu	2
Fe	< 30
Pb	< 0.05
Mn	3,470
Mo	30.8
Ni	2.3
Se	29
U	20
Zn	15

Regardless of the predicted water quality, all discharge to Outfall 005 would need to meet whatever NPDES permit limits (renewed every 5 years) were in effect at the time of discharge: "the outfall 005 discharge must not result in a reduction of the ambient water quality of the Salmon River as measured below the mixing zone" (TCMC NPDES permit, EPA 2007).

The above-described water quality of Thompson Creek, S. Creek, and at NPDES Outfall 005 were used to estimate the water quality for the Salmon River downstream of its confluence with S. Creek for the average annual low flow (388 cfs) and 7Q10 flow (103 cfs) (Table 4.6-7., Table 4.6-8). The background water quality of the receiving water (Salmon River) was set as the 95th percentile of the 4 year record of water quality from only the months of low flow at SR3. The numeric WQSs would be met for all of the scenarios (negligible effect). Note that the current NPDES limits (not assessed below as the limits are all at or above the WQSs) are for the

concentrations of total metals (dissolved and present on suspended particles in the water), whereas the predicted water quality and WQSs are based on only the concentrations of dissolved metals (except for selenium, see Table 4.6-7, note 1). The differences between the concentrations of total and dissolved metals in the treated water would be very small because of the low concentrations of particles in the treated water (i.e., settled lake water that has been further clarified and filtered), but these differences would need to be considered in the future, because it would be part of the IDEQ mixing analysis for the NPDES permit.

Table 4.6-7. Salmon River water quality, low-flow, Alternative M1.
all units are µg/L except mg/L for SO_4^{2-}

Parameter[1]	Existing Salmon River Receiving Water Quality	Predicted Salmon River Water Quality		CMC[2]	CCC[2]
		Best Estimate	Upper Estimate		
SO_4^{2-}	8.6	16.7	16.8	N/A	N/A
Al	10.6	23.0	23.6	N/A	N/A
As	1.57	1.6	1.6	340	150
Cd	0.050	0.06	0.07	0.9	0.43
Co	0.100	0.15	0.16	N/A	N/A
Cu	0.40	0.48	0.53	10.8	7.5
Fe	30.0	31.3	31.3	N/A	N/A
Pb	0.050	0.06	0.06	38	1.5
Mn	1.87	20.8	21.6	N/A	N/A
Mo	2.8	3.1	3.1	N/A	N/A
Ni	0.6	0.70	0.75	312	35
Se-T	1.0	1.2	1.2	20	5
U	2.0	2.2	2.2	N/A	N/A
Zn	3.7	4.2	4.5	78	79

[1] Dissolved metal data were used for all metals except selenium, since the selenium guideline applies to the concentration of total selenium.
[2] CMC/CCC standards assuming a hardness of 62 mg/L

Table 4.6-8. Salmon River water quality, 7Q10 flow, Alternative M1.
all units are µg/L except mg/L for SO_4^{2-}

Parameter[1]	Existing Salmon River Receiving Water Quality	Predicted Salmon River water quality		CMC[2]	CCC[2]
		Best Estimate	Upper Estimate		
SO_4^{2-}	8.6	35.6	35.8	N/A	N/A
Al	10.6	56.1	58.4	N/A	N/A
As	1.57	1.6	1.6	340	150
Cd	0.050	0.10	0.12	0.9	0.43
Co	0.100	0.27	0.33	N/A	N/A
Cu	0.40	0.64	0.84	10.8	7.5
Fe	30.0	32.7	32.8	N/A	N/A
Pb	0.050	0.07	0.08	38	1.5
Mn	1.87	73.1	76.3	N/A	N/A
Mo	2.8	3.6	3.6	N/A	N/A
Ni	0.6	0.90	1.08	312	35
Se-T	1.0	1.7	1.7	20	5
U	2.0	2.6	2.7	N/A	N/A
Zn	3.7	5.3	6.5	78	79

[1] Dissolved metal data were used for all metals except selenium, since the selenium guideline applies to the concentration of total selenium.
[2] CMC/CCC standards assuming a hardness of 62 mg/L

Regarding antidegradation, the concentrations of all of the constituents would be less than the 10 percent threshold for the Salmon River under all analyzed scenarios except for the 7Q10 flow/best estimate – cadmium and selenium, and the 7Q10 flow/upper estimate – cadmium and selenium (long-term, infrequent, minor effects). However, as noted previously, the discharge from Outfall 005 could potentially be managed as necessary to avoid discharge during extreme low flow conditions and to avoid degradation of Salmon River water quality.

Open Pit

The rock at the TCM open pit contains low concentrations of sulfide minerals (i.e., typically < 1 % sulfur) and metals (e.g., ~ 0.1 % molybdenum and < 0.005 % copper in the ore; much lower concentrations in the waste rock) (Doughty 2012). For example, in contrast the rock at the Berkeley open pit in Butte, Montana contains high concentrations of sulfide minerals (i.e., ~ 4 % sulfur) and metals (e.g., 0.8 % copper). More importantly, the Berkeley Pit is connected to 10,000 miles of underground workings in rock containing extremely high concentrations of

sulfide minerals (e.g., > 30 % sulfur in places) and metals (e.g., up to 80 % copper). As a result, the water in the Berkeley pit is very acidic (~ pH 2.5) and contains as much as 1,000,000 µg/L iron and 200,000 µg/L copper (Gammons and Duaime 2006; Gammons et al. 2006; Luoma et al. 2008, MBMG 2013), whereas the water in the TCM pit is neutral (pH 7.2 to pH 7.5) and contains 500 µg/L iron and 2.5 µg/L copper (Doughty 2012). Pit lake water quality will be managed to ensure neutral conditions (and as a result lower concentrations of metals) persist in the long-term. During long-term water treatment at the TCM, the pit would continue to have neutral pH and very low concentrations of metals (e.g., 300 µg/L iron and 100 µg/L copper) compared to the extremely high concentrations of metals in the Berkeley Pit. The water released from the TCM pit would be alkaline (pH 8.7) and have even lower concentrations of metals, e.g., 5.5 µg/L iron and 2 µg/L copper. For reference, the EPA primary drinking water standard for copper is 1,300 µg/L (EPA 2014); the Idaho WQSs (CCC exposure to aquatic life for a hardness of 100 mg/L $CaCO_3$) is 11 µg/L; the NPDES permit limit for copper for the mine is 3 to 20 µg/L depending on the flow of the receiving stream; and the typical concentration of copper in water samples collected as part of water quality monitoring at the mine is approximately 0.3 µg/L (TCMC 2013). Note also that while the effects to water quality are described as long-term, the water management system would be structured to operate in perpetuity.

Surface Water Rights

There would be no effects to water rights for surface waters. There would be no physical disruption of points of diversion or water sources associated with water rights, nor would there be any water quality issues that would prevent a water right holder from using their source water.

Groundwater

Buckskin Creek Watershed

The baseline groundwater conditions would continue, except for a reduction in constituents to Thompson Creek due to the installation of a groundwater cutoff wall downgradient of the Buckskin WRSF to capture groundwater seepage from the facility. A vertical wall of cement with a high density polyethylene (HDPE) liner would be keyed (anchored) into the bedrock at the base of the alluvial/colluvial rock layer, and would capture essentially all groundwater seepage from the facility except for small amounts of leakage through the wall (240 gallons/day) and around it (2,282 gallons/day via the metasedimentary rock). The cutoff wall would substantially reduce the loads of constituents in seepage from the WRSF (BuckC) (Table 4.6-9.) which would be delivered via groundwater (i.e., leakage around and through the wall) to Thompson Creek (Table 4.6-10). The loads were calculated using the cross-sectional area of the aquifer, the flow rates (with and without the wall) through the aquifer, and the estimates of the concentrations of constituents in the seepage from the WRSF (Buck C). Other important assumptions were summarized previously (Section 4.6.1.1.1).

The best estimate was conservatively calculated using the highest measured concentrations instead of the median concentrations in the monitoring data. The exceptions are the concentrations of sulfate and molybdenum, which were calculated from a geochemical model using solubility controls. As a result, the concentrations of sulfate and molybdenum used in the

best estimate were higher than their maximum measured concentrations in the monitoring data. The upper estimate is based on the improbable scenario that the WRSF would exhaust its ability to buffer acidity at some time in the future and become acidic. The rate of degradation of the cutoff wall over time is difficult to predict, but would vary with the amount of cracking and the chemistry of the water in contact with the wall. Regardless, the cutoff wall would be expected to operate as designed for at least 30 years (e.g., EPA 1998), and would be closely monitored and maintained/rebuilt as necessary.

Table 4.6-9. Buckskin WRSF (BuckC) water quality behind cutoff wall.
all units are mg/L except s.u. for pH

Parameter	Alternative M1 Best Estimate	Alternative M1 Upper Estimate	Measured (Max.)	Measured (Median)	Idaho Groundwater Standards
pH	7.9	**4.7**	**8.7**	8.0	6.5-8.5[2]
SO_4^{2-}	**1690**	**1868**	**1120**	**847**	250[2]
Al	0.0023	**22**	0.044	0.002	0.2[2]
Cd	0.00037	**0.024**	0.00037	0.00009	0.005[1]
Co	0.0014	0.15	0.0014	0.0004	
Cu	0.0045	0.14	0.0045	0.0012	1.3[1]
Mn	0.029	9.6	0.028	0.0013	
Mo	**0.59**	0.004	**0.072**	0.037	0.05[2]
Ni	0.0079	0.032	0.0078	0.0018	
Pb	0.00013	0.0079	0.00013	< 0.00005	0.015[1]
Se-T	0.047	0.043	0.047	0.034	0.05[1]
U	0.012	0.16	0.012	0.010	
Zn	0.029	1.8	0.029	0.004	5[2]

[1] primary standard, IDAPA 58.01.11
[2] secondary standard, IDAPA 58.01.11
bold typeface indicates exceeds Idaho Groundwater Standard

Reclamation of the WRSF would include a soil cap, revegetation, a sloped surface to divert water to the margins, and water diversion ditches along the margins, all of which would substantially reduce the amount of surface water currently infiltrating into the facility. Comparing the last column in Table 3.6-17 with the best estimate (Table 4.6-10) shows how the cutoff wall would remove mine-affected groundwater from the colluvium and reduce a major portion of the constituent load that currently reaches Thompson Creek. These analyses do not reflect the reduced infiltration that would occur when the cap is installed during reclamation.

Table 4.6-10. Loads in groundwater, Buckskin Creek watershed to Thompson Creek during mining.

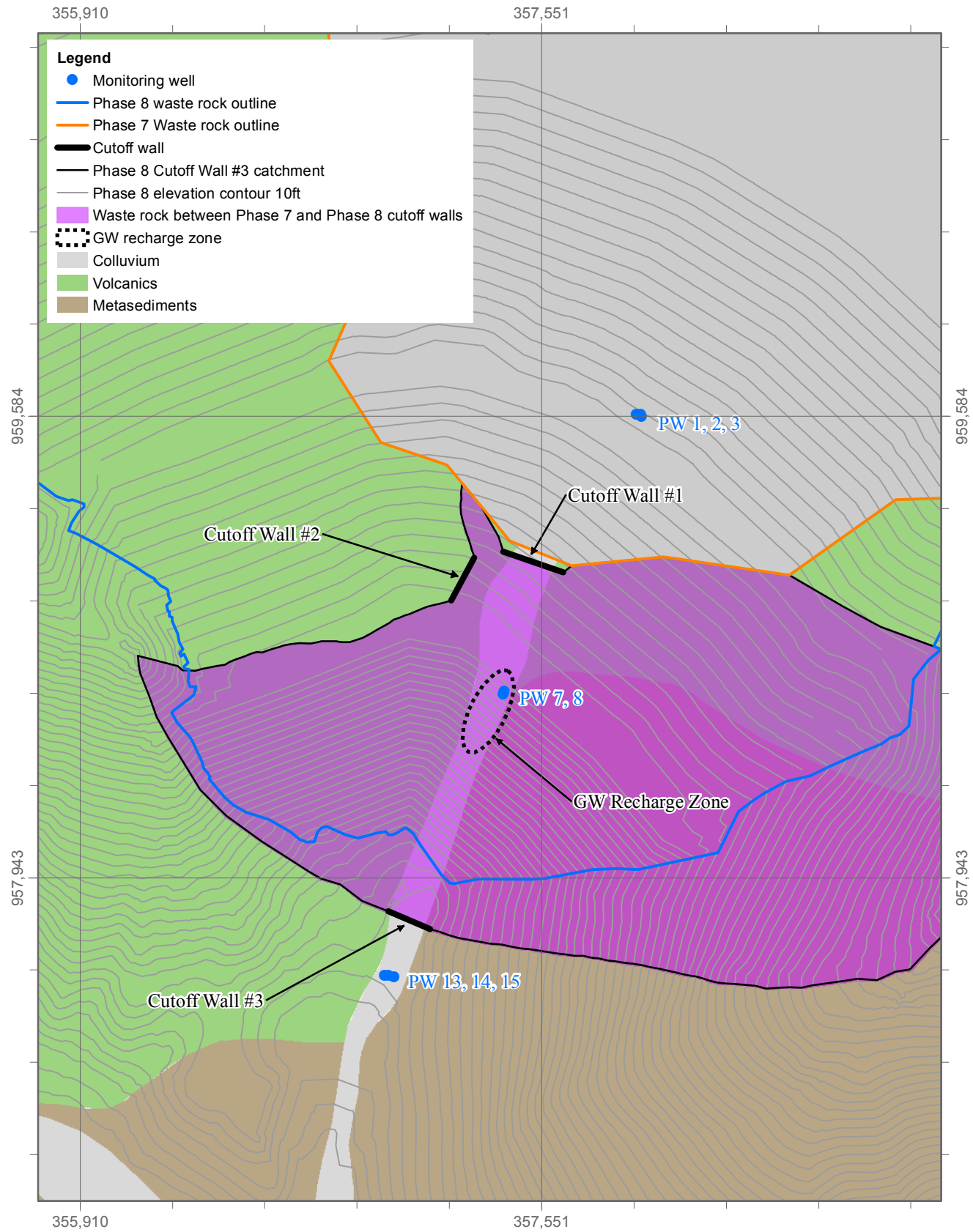
all units are pounds/day

Parameter	Current (2010)[1]	Alt. M1 with Cutoff Wall Best Estimate[2]	Alt. M1 with Cutoff Wall Upper Estimate[2]
SO_4^{2-}	146	2.76	6.45
Al	0.00036	0.00006	0.04422
As	0.00016	0.00015	0.00016
Cd	0.00006	$1.91x10^{-6}$	0.00005
Co	0.00008	$1.91x10^{-6}$	0.00031
Cu	0.00006	0.00002	0.00030
Fe	0.00057	0.00057	0.00080
Mn	0.00017	0.00013	0.01937
Mo	0.01636	0.00091	0.00090
Ni	0.00030	0.00001	0.00007
Pb	0.00001	$1.91x10^{-6}$	0.00002
Se-T	0.00509	0.00006	0.00015
U	0.00180	0.00030	0.00063
Zn	0.00130	0.00004	0.00366

[1] Wells BW2 (metasedimentary rocks) and BW4 (colluvium)
[2] BuckC

Pat Hughes Creek Watershed

The baseline groundwater conditions would continue, except for a reduction in constituents to Thompson Creek due to the installation of a groundwater cutoff wall (Cutoff Wall #1) downgradient of the Pat Hughes WRSF (Figure 4.6-4., Figure 4.6-5). Cutoff Wall #2 and Cutoff Wall #3 would capture seepage from waste rock only under Alternative M2 (Section 4.6.1.2.2). Cutoff Wall #1 would substantially reduce the amount of constituents in the seepage from the WRSF (PHtoe) (Table 4.6-11.) which would be delivered via groundwater to Thompson Creek. The cutoff wall would capture primarily water from the colluvium, which is more affected by seepage and of generally lower quality than water in the underlying metasedimentary rocks (Table 3.6-22). In other words, water getting past the cutoff wall would more closely resemble the quality of baseflow seepage than that from spring snowmelt (Table 4.6-11).

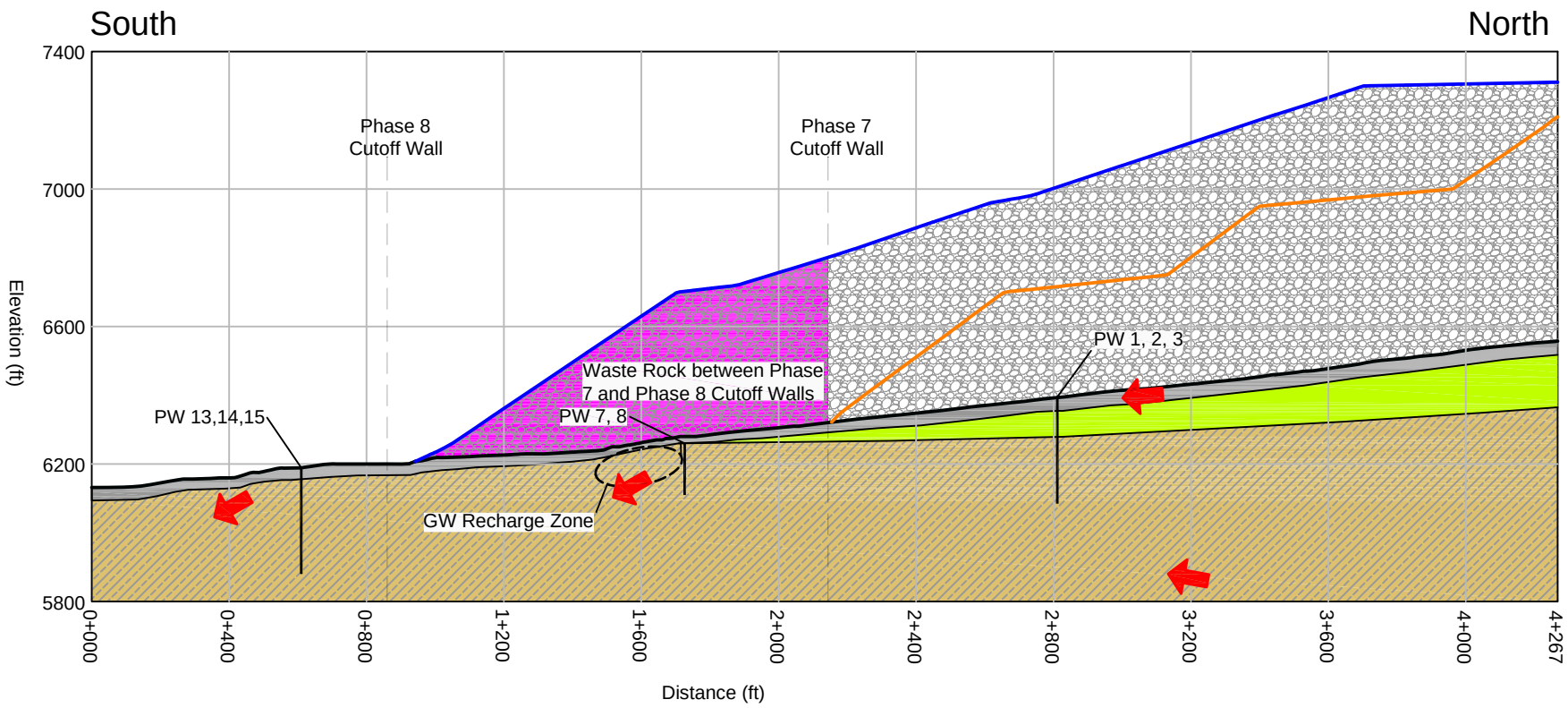


N

0 1:6,000 500
0 Feet 200
Meters

Data source JBR (2012g)

Figure 4.6-4
Groundwater cutoff walls, Pat Hughes Creek watershed
Thompson Creek Mine EIS



LEGEND

- Original topography
- Phase 7 topography
- Phase 8 topography
- Groundwater recharge zone
- Flow direction
- Waste rock between Phase 7 and Phase 8 cutoff walls
- Waste rock
- Volcanics
- Metasediments

Vertical Exaggeration: 1X

Scale: 1:6000

Units: *Feet*

0 200 400

Source: JBR 2012g

No warranty is made by the Bureau of Land Management (BLM) for the use of this data for purposes not intended by the BLM.

Figure 4.6-5
Groundwater cutoff walls, cross-section,
Pat Hughes Creek watershed
Thompson Creek Mine EIS

The calculations of groundwater quality in the Pat Hughes Creek drainage that discharges to Thompson Creek are particularly conservative as the calculations used the chemistry of pore water (Table 4.6-11). In reality, the seepage leaving the Pat Hughes WRSF would be diluted by non-mine-affected groundwater recharged from areas outside the footprint of the WRSF. In addition, chemical reactions in the seepage as it migrates from the facility would further decrease the concentrations of chemicals compared to their concentrations in the pore water within the WRSF. Different concentrations of constituents were calculated for base flow and spring snowmelt because seepage from the facility has the highest concentrations of metals and other constituents during spring melt.

Table 4.6-11. Pat Hughes WRSF (PHtoe) water chemistry, Alternative M1.
all units are mg/L except s.u for pH and mg/L $CaCO_3$ for acidity

Parameter	Maximum Pore Water Estimate	Alternative M1, Mining, Base flow	Alternative M1, Mining, Spring Snowmelt	Idaho Groundwater Standards
pH	**3.5**	**4.56**	**3.65**	6.5-8.5[2]
SO_4^{2-}	**2,460**	**1,540**	**2,220**	250[2]
Al	**93**	**54**	**83**	0.2[2]
As	**0.4**	0.004	0.017	0.05[1]
Cd	**0.110**	**0.055**	**0.081**	0.005[1]
Co	2.2	0.35	0.51	
Cu	**3.5**	0.41	**2.6**	1.3[1]
Fe	**1.4**	0.11	**0.57**	0.3[2]
Mn	**34.6**	**22.6**	**33.3**	0.05[2]
Mo	0.011	0.008	0.009	
Ni	0.1	0.061	0.09	
Pb	**0.094**	0.006	**0.063**	0.015[1]
Se-T	0.033	0.02	0.03	0.05[1]
U	0.82	0.36	0.53	
Zn	**9.3**	4.3	**6.3**	5[2]
Acidity	734	341	535	

[1] primary standard, IDAPA 58.01.11
[2] secondary standard, IDAPA 58.01.11
bold typeface indicates exceeds Idaho Groundwater Standard

The water chemistry and constituent loading, respectively, to Thompson Creek from the Pat Hughes watershed were estimated following closure and reclamation (Table 4.6-12. and Table 4.6-13). The same closure methods that would be used at the Buckskin WRSF would be used at the Pat Hughes WRSF, including cutoff walls, a soil cap and revegetation on recontoured waste rock to reduce infiltration, grading to route overland flow away from the waste rock, and lined channels to route run-on from undisturbed areas of the watershed around the facility rather than through it. The cap for the Pat Hughes WRSF would be multi-layered and thicker than the one used at Buckskin to control infiltration to a greater degree than for the Buckskin facility. The constituent loads do not account for reduced infiltration after reclamation (Table 4.6-13).

Table 4.6-12. Pat Hughes Creek watershed water chemistry.
all units are µg/L except s.u. for pH and mg/L for SO_4^{2-}

Parameter	PW11[1] Metasedimentary Rock	Alternative M1 Leakage Around Cutoff Wall #1		Idaho Groundwater Standards
	Mean	Best Estimate	Upper Estimate	
pH	7.63	**4.6**	**3.5**	6.5-8.5[3]
SO_4^{2-}	245	**1,490**	**2,460**	250[3]
Al	27	**52,000**	**93,000**	200[3]
As	8.0	4.0	4.0	50[2]
Cd	0.04	**53**	**110**	5[2]
Co	1.15	340	2,200	
Cu	0.15	410	**3,500**	1,300[2]
Fe	110	110	**1,400**	300[5]
Pb	0.12	6.0	**94**	15[3]
Mn	**170**	**21,900**	**34,600**	50[3]
Mo	6.0	8.0	11	
Ni	2.0	59	100	
Se-T	1.0	19	33	50[2]
U	9.0	350	820	
Zn	22.0	4,100	**9,300**	5,000[3]

[1] mean measured concentrations in groundwater metasedimentary bedrock at PW11
[2] primary standard, IDAPA 58.01.11
[3] secondary standard, IDAPA 58.01.11
bold typeface indicates exceeds Idaho Groundwater Standard

Water collected from the WRSF would not be discharged through NPDES Outfall 002; rather, this water would be pumped to a lime treatment plant where the pH of the water would be neutralized before the water would be added to the pit lake. Well PW11 (Table 4.6-12.) is based in metasedimentary rock to a medium depth and is the most downgradient well (closest to Thompson Creek); water quality in PW11 is believed to be the closest approximation to groundwater that reaches Thompson Creek. Leakage is based on estimated water quality that would go through or around the cutoff wall.

Loading (Table 4.6-13.) was calculated using the cross-sectional area of the aquifer, flow rate through the aquifer, and water quality. The total load to Thompson Creek is the sum of the amount of the constituents in the water in the metasedimentary rock and that in the water that leaks through and around the cutoff wall (Table 4.6-13).

Table 4.6-13. Loads in groundwater, Pat Hughes Creek watershed to Thompson Creek.
all units are pounds/day

Parameter	PW11[1] Meta-sedimentary Rock	Alternative M1 Best Estimate		Alternative M1 Upper Estimate	
	Mean	Cutoff Wall #1	Total Load	Cutoff Wall #1	Total Load
SO_4^{2-}	32.7	0.083	32.77	11.47	44.2
Al	$3.62x10^{-6}$	0.00290	0.00286	0.43339	0.43339
As	$1.07x10^{-6}$	$1.91x10^{-7}$	$1.91x10^{-6}$	0.00002	0.00002
Cd	$3.81x10^{-9}$	$3.05x10^{-6}$	$3.81x10^{-6}$	0.00051	0.00051
Co	$1.52x10^{-7}$	0.00002	0.00002	0.01025	0.01029
Cu	$1.91x10^{-8}$	0.00002	0.00002	0.01631	0.01638
Fe	0.00001	0.00001	0.00002	0.00653	0.00648
Pb	$1.52x10^{-8}$	$3.81x10^{-7}$	$3.81x10^{-7}$	0.00044	0.00044
Mn	0.00002	0.00122	0.00124	0.51968	0.16135
Mo	$8.00x10^{-7}$	$3.81x10^{-7}$	$1.91x10^{-6}$	0.00006	0.00006
Ni	$2.67x10^{-7}$	$3.24x10^{-6}$	$3.81x10^{-6}$	0.00046	0.00046
Se-T	$1.33x10^{-7}$	$1.14x10^{-6}$	$1.91x10^{-6}$	0.00015	0.00015
U	$1.14x10^{-6}$	0.00002	0.00002	0.00381	0.00383
Zn	$2.97x10^{-6}$	0.00023	0.00023	0.04343	0.04343

[1] mean measured concentrations in groundwater in metasedimentary bedrock at PW11

No Name Creek Watershed

There would not be any facilities or operations in the No Name Creek watershed, and there would be no effects to groundwater in the watershed during mining, reclamation, or post-reclamation.

Open Pit

The pit would be developed as previously described (e.g., Section 2.1.1.3., Section 2.1.1.8., Section 2.1.3.2) and the current water management would continue. After mining, the pit lake would develop (described as a surface feature, Section 4.6.1.1.1.) with an inward groundwater flow. As the pit lake develops, water from the deeper portion of the pit would begin to flow outward as groundwater, which would probably flow to the southwest into the Buckskin Creek watershed, but could find a pathway into the Pat Hughes Creek watersheds or into Thompson Creek (Section 4.6.1.2.2).

Bruno Creek Watershed

The amount of seepage from the TSF in the Bruno Creek watershed that reaches the Redbird Creek watershed would increase as the height of the impoundment rises which would increase the hydraulic head. The best estimate of the seepage quality is based on an estimated flow of 35 gpm and the median concentrations of the constituents measured in 2010. The upper estimate is based on a flow of 37.5 gpm and the maximum concentrations measured in 2010 (Table 4.6-14). The constituent loads to Redbird Creek would be relatively small (Table 4.6-15).

Table 4.6-14. Redbird Creek seepage quality.
all units are µg/L except mg/L for SO_4^{2-}

Parameter	Median 2010	Maximum 2010	Idaho Groundwater Standards
SO_4^{2-}	**1,230**	**1,360**	250[2]
Al	1	4.0	200[2]
As	2.5	6.5	50[1]
Cd	0.2	0.71	5[1]
Co	4.5	5.0	
Cu	0.1	5.0	1,300[1]
Fe	30	**5,920**	300[2]
Mn	**4,910**	**5,350**	50[2]
Mo	672	774	
Ni	12	13.9	
Pb	0.00005	0.000054	15[1]
Se-T	0.001	0.0011	50[1]
U	6	7.5	
Zn	5	15.0	5,000[2]

[1] primary standard, IDAPA 58.01.11
[2] secondary standard, IDAPA 58.01.11
bold typeface indicates exceeds Idaho Groundwater Standard

Table 4.6-15. Loads in groundwater to Redbird Creek and S. Creek from the TSF.
all units are pounds/day

Parameter	Alternative M1 Best Estimate	Alternative M1 Upper Estimate
SO_4^{2-}	0.50940	0.54731
Al	0.00042	0.00168
As	0.00088	0.00202
Cd	0.00008	0.00009
Co	0.00198	0.00211
Cu	0.00004	0.00211
Fe	1.07366	1.60401
Mn	2.05245	2.11341
Mo	0.00042	0.00042
Ni	0.00505	0.00547
Pb	0.00002	0.00002
Se-T	0.00042	0.00042
U	0.00253	0.00295
Zn	0.00211	0.00589

After mining (no more tailings slurry to the TSF) much of the water in the impoundment would gradually drain from the TSF, and the surface of the impoundment would be sloped to drain precipitation from the impoundment. Both the impoundment and the embankment would have a soil cap with vegetation, but precipitation to the surface of the embankment would infiltrate into the embankment (less what is removed by evapotranspiration). Therefore, the ratio of the water draining from the impoundment (neutral pH currently and in the long-term) to the water draining from the embankment (neutral but may become acidic pH in the long-term) would decrease over time, i.e., the water draining from the TSF would be dominantly from the embankment and the water would probably become acidic with elevated concentrations of constituents in the long-term (Table 4.6-16). Note that molybdenum, which is most soluble at neutral pH, would have a higher concentration under current conditions, as opposed to that of all of the other metals.

To estimate the seepage quality from the TSF over the long term, the projected long-term water quality of seepage from the embankment was used since that will increasingly dominate seepage from the impoundment, which will decrease over time; this provides a conservative estimate of the long-term seepage water quality.

Table 4.6-16. TSF current and future drainage chemistry.
all units are mg/L except s.u. for pH and mg/L $CaCO_3$ for alkalinity and acidity

Parameter	Current Concentration	Predicted Maximum Concentration of Embankment Sands Seepage	Idaho Groundwater Standards
pH	6.9	**4.0**	6.5-8.5[2]
Alkalinity	130	--	
Acidity	--	145	
SO_4^{2-}	**1,250**	**1,915**	250[2]
Al	0.003	**16**	0.2[2]
As	0.0032	0.020	0.05[1]
Cd	0.0003	**0.3**	0.005[1]
Co	0.0048	0.44	
Cu	0.001	**1.9**	1.3[1]
Fe	0.03	**0.9**	0.3[2]
Mn	**4.9**	**25**	0.05[2]
Mo	0.690	0.001	
Ni	0.013	2.1	
Pb	0.00005	**0.1**	0.015[1]
Se-T	0.001	0.009	0.05[1]
Sr	7,400	20,000	
Zn	0.0076	**13**	5[2]

[1] primary standard, IDAPA 58.01.11
[2] secondary standard, IDAPA 58.01.11
bold typeface indicates exceeds Idaho Groundwater Standard

The potential constituent loads to Bruno Creek from the TSF are from calculations of predicted long-term embankment seepage water quality multiplied by two flows. The best-estimate flow (3.9 gpm) was calculated from the saturated thickness of the colluvium below the SRD, its hydraulic conductivity, and the topographic gradient between MW1 and MW2. The best-estimate flow was doubled (8 gpm) for the upper estimate (Table 4.6-17).

Table 4.6-17. Loads in groundwater to Bruno Creek from TSF embankment seepage bypassing the SRD.

all units are pounds/day

Parameter	Alternative M1 Best Estimate	Alternative M1 Upper Estimate
SO_4^{2-}	0.09125	0.18250
Al	0.76200	1.52400
As	0.00095	0.00191
Cd	0.01429	0.02858
Co	0.02096	0.04191
Cu	0.09049	0.18098
Fe	0.04286	0.08573
Pb	0.00476	0.00953
Mn	1.19063	2.38125
Mo	0.00005	0.00010
Ni	0.10001	0.20003
Se-T	0.00044	0.00086
U	0.05239	0.10478
Zn	0.61913	1.23825

After reclamation, as the tailings consolidate and the saturation level declines (excluding the water trapped long-term in the sediments) in the TSF, the flow of groundwater from the TSF reaching the Redbird Creek watershed would decrease from 35 gpm to no flow, and the loads of sulfate and chloride would decrease proportionally.

Springs

The quantity and quality of the springs along Thompson Creek would not be meaningfully affected by the mine, i.e., even if the springs were recharged by bedrock groundwater flowing from the north (instead of the more probable recharge from Thompson Creek) the groundwater affected by mining is considered to be hydraulically isolated from the springs (in part due to strong upward hydraulic gradients and the presence of low permeability Challis volcanic rock).

There would probably be negligible effects to the quantity and quality of two springs in the Buckskin Creek watershed for which TCMC has water rights. That is, TCMC would continue to use the same amount of water from the springs, and the groundwater quality that is probably associated with the springs would not change. There would be no effects to springs in the No Name Creek watershed. Similarly, the springs in the Pat Hughes Creek watershed and in the unnamed watershed to the east would not be affected. There would be no changes to

groundwater flow in the Bruno Creek drainage. Therefore, there would be negligible effects to the quantity and quality of the springs in the Bruno Creek watershed.

4.6.1.2. Alternative M2 – MMPO as Submitted by TCMC

Surface Water

Water management would continue essentially unchanged from Alternative M1 (Figure 4.6-6., Figure 4.6-7., Figure 4.6-8). The differences in the effects between the two alternatives (summarized below) would be due to the increased areas of disturbance and the increased volumes of the pit, WRSFs, and TSF. The resultant chemistry of the pit lake also changes, compared to Alternative M1 (Table 4.6-5.), due to the changing ratios of contributing water (i.e., surface run-off from upgradient areas, groundwater inflow, direct precipitation, pit wall run-off, and treated WRSF water. However, as described below, the chemistry of the pit lake does not reflect what would be discharged at Outfall 005; with treatment, the quality of this water would be the same under both Alternative M1 and Alternative M2.

Thompson Creek and Tributaries

Low-flow Conditions

The Buckskin cutoff wall and two of the Pat Hughes cutoff walls (only one of which would be functional under Alternative M1) would remain in place and functional. A third cutoff wall would be installed in the Pat Hughes Creek watershed near the toe of the WRSF. For the Buckskin facility, the same quantity of colluvial groundwater would be captured as under Alternative M1. For the Pat Hughes facility, the additional cutoff walls would increase the amount of captured groundwater, thus reducing the flow to Thompson Creek by approximately 240 gpm on average (negligible effect). A small amount of shallow groundwater is estimated to pass through or around the cutoff walls in the Buckskin Creek and Pat Hughes Creek watersheds and deliver constituents to Thompson Creek. The difference in such loads from the Pat Hughes Creek watershed between the alternatives would be due to the increased footprint and volume of the Pat Hughes WRSF. The effect of the constituent loads on the water quality of Thompson Creek was assessed in the same manner as for Alternative M1 for both low flow (Table 4.6-18.) and the 7Q10 flow (Table 4.6-19).

Table 4.6-18. Thompson Creek water quality, low flow, Alternative M2.
all units are µg/L except mg/L for SO_4^{2-}

Parameter[1]	Existing Thompson Creek Receiving Water Quality	Predicted Thompson Creek Water Quality		CMC[2]	CCC[2]
		Best Estimate	Upper Estimate		
SO_4^{2-}	14	20.2	23.5	N/A	N/A
Al	8.8	9.5	104.2	N/A	N/A
As	0.5	0.5	0.5	340	150
Cd	0.05	0.05	0.16	0.71	0.37
Co	0.1	0.11	2.32	N/A	N/A
Cu	0.8	0.82	4.34	8.4	6.0
Fe	30	30	32	N/A	N/A
Pb	0.075	0.08	0.17	28	1.1
Mn	0.48	0.8	112.9	N/A	N/A
Mo	2.07	2.5	2.6	N/A	N/A
Ni	0.46	0.5	0.6	247	27
Se-T	1.95	2.2	2.3	20	5
U	1	1.1	1.9	N/A	N/A
Zn	3	3.1	12.6	62	62

[1] Dissolved metal data were used for all metals except selenium, since the selenium guideline applies to the concentration of total selenium.
[2] CMC/CCC standards assuming a hardness of 47 mg/L

Source	Description	Flow Estimates best	upper
a	Buckskin cutoff seepage - colluvium (gpm)	0.002	0.166
	Buckskin metasediment groundwater (gpm)	1.59	1.59
b	Pat Hughes cutoff seepage - colluvium (gpm)	0.027	1.94
	Pat Hughes metasediment groundwater (gpm)	11.1	11.1
c	Seepage via Redbird (gpm)*	45	45
d	Seepage via Bruno (gpm)**	3.9	8.0
e	Treated water (cfs) via outfall 005 after year 70	2.1	2.1

*only during early closure **only during late closure

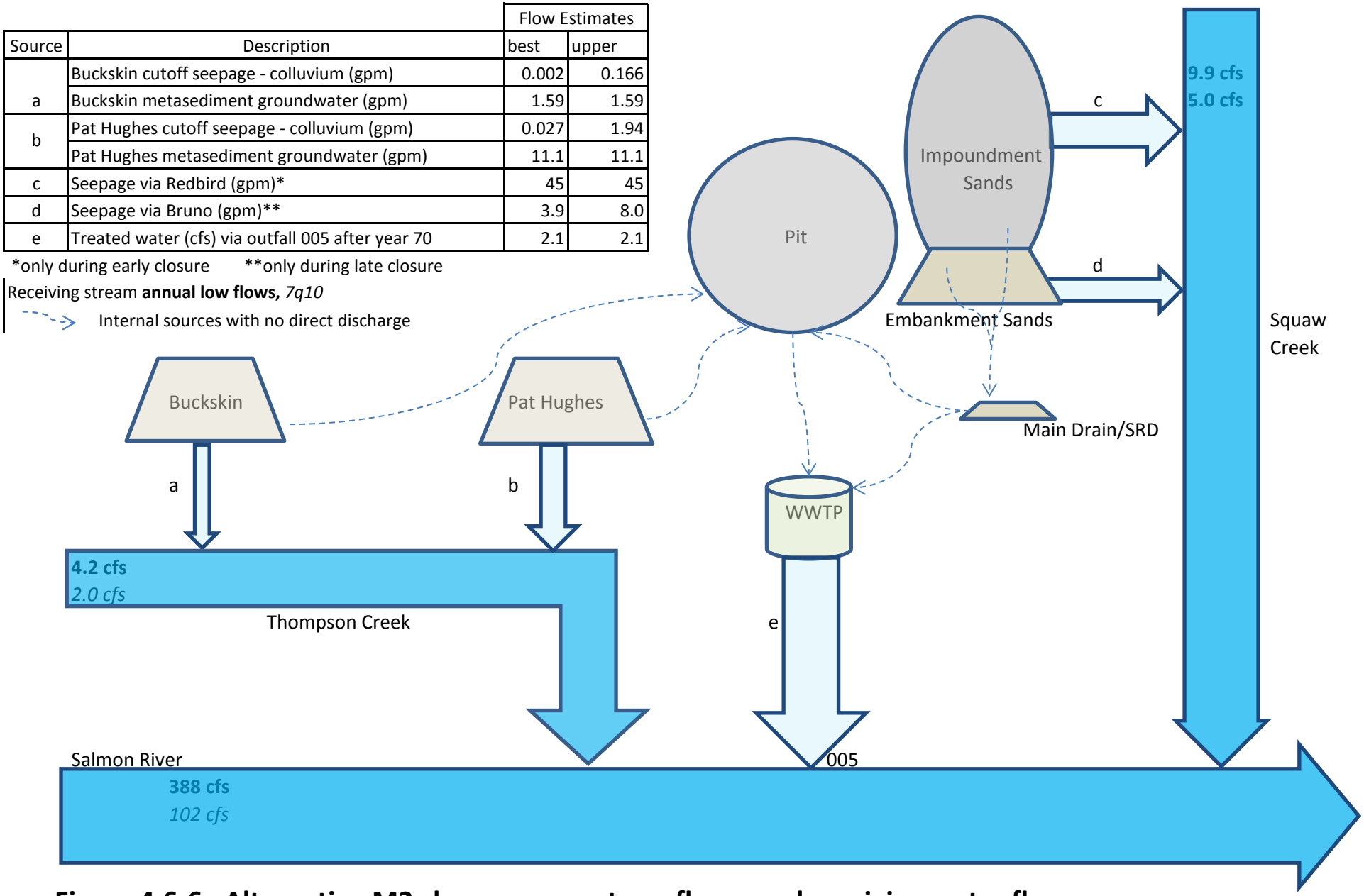


Figure 4.6-6. Alternative M2 closure source term fluxes and receiving water flows.

Flow Arrow	Description			Average (gpm)	Range (gpm) Min	Max
a	Buckskin to Lime Plant	Best Estimate		53	0	359
		Upper Estimate		166	54	881
b	Pat Hughes to Lime Plant	Best Estimate		149	83	608
		Upper Estimate		149	83	608
c	Lime Plant to Pit	Best Estimate	high flow	123	0	513
			low flow	80	0	608
		Upper Estimate	high flow	315	142	1,417
			low flow	0	0	0
d	Runoff to Pit			13	3	120
e	Main Drain Seepage			739	456	1,385
f	Discharge to WWTP			0	0	0

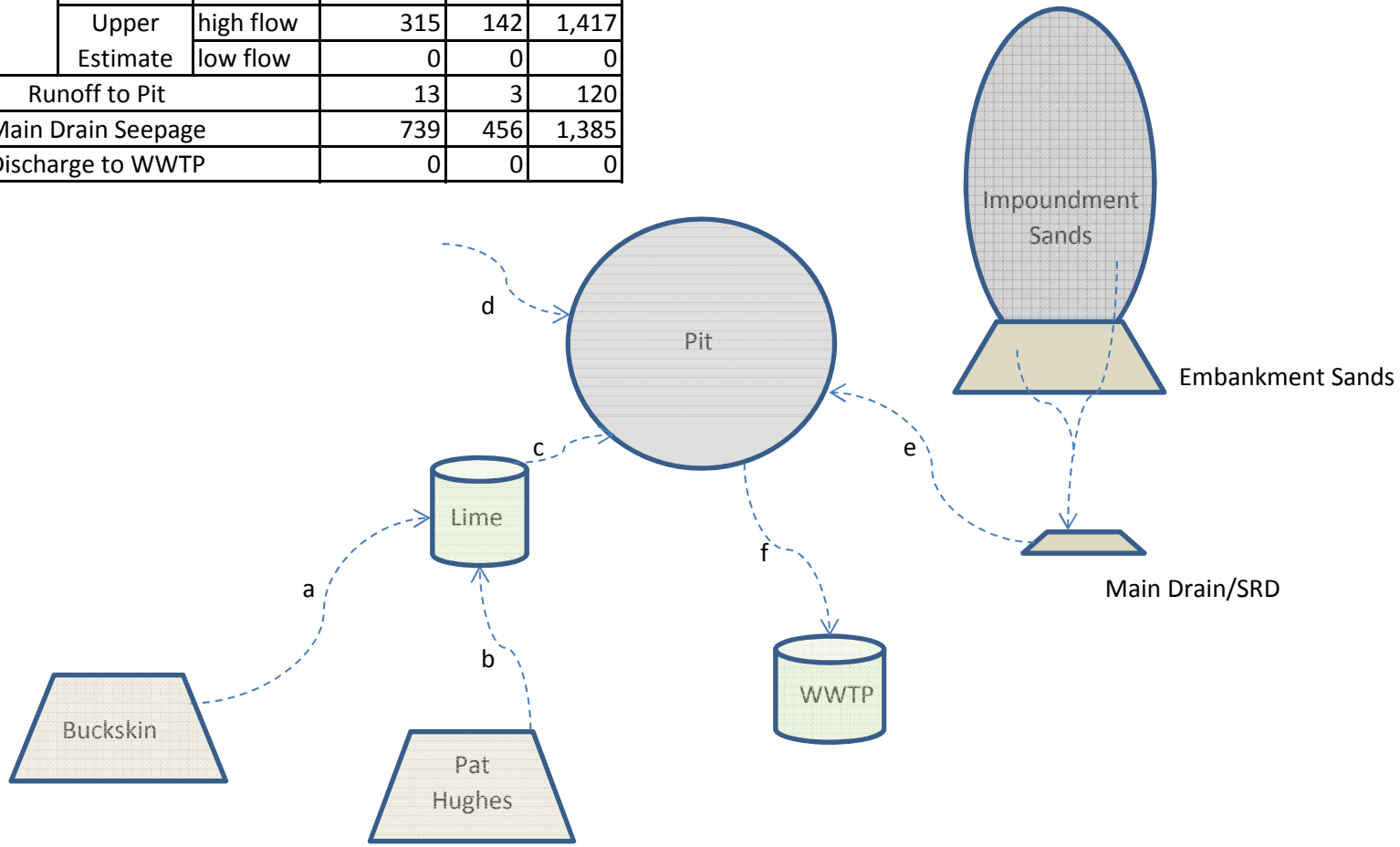


Figure 4.6-7. Alternative M2 water management, years 1-5.

Flow Arrow	Description			Average (gpm)	Range (gpm) Min	Max
a	Buckskin to Lime Plant	Best Estimate		51	0	403
		Upper Estimate		219	45	1,497
b	Pat Hughes to Lime Plant	Best Estimate		239	70	1,579
		Upper Estimate		239	70	1,579
c	Lime Plant to Pit	Best Estimate	high flow	128	0	994
			low flow	150	0	1,579
		Upper Estimate	high flow	440	120	3,069
			low flow	0	0	0
d	Runoff to Pit			36	3	654
e	Main Drain Seepage			145	---	
f	Discharge to WWTP from Year 28			655	0	15,523

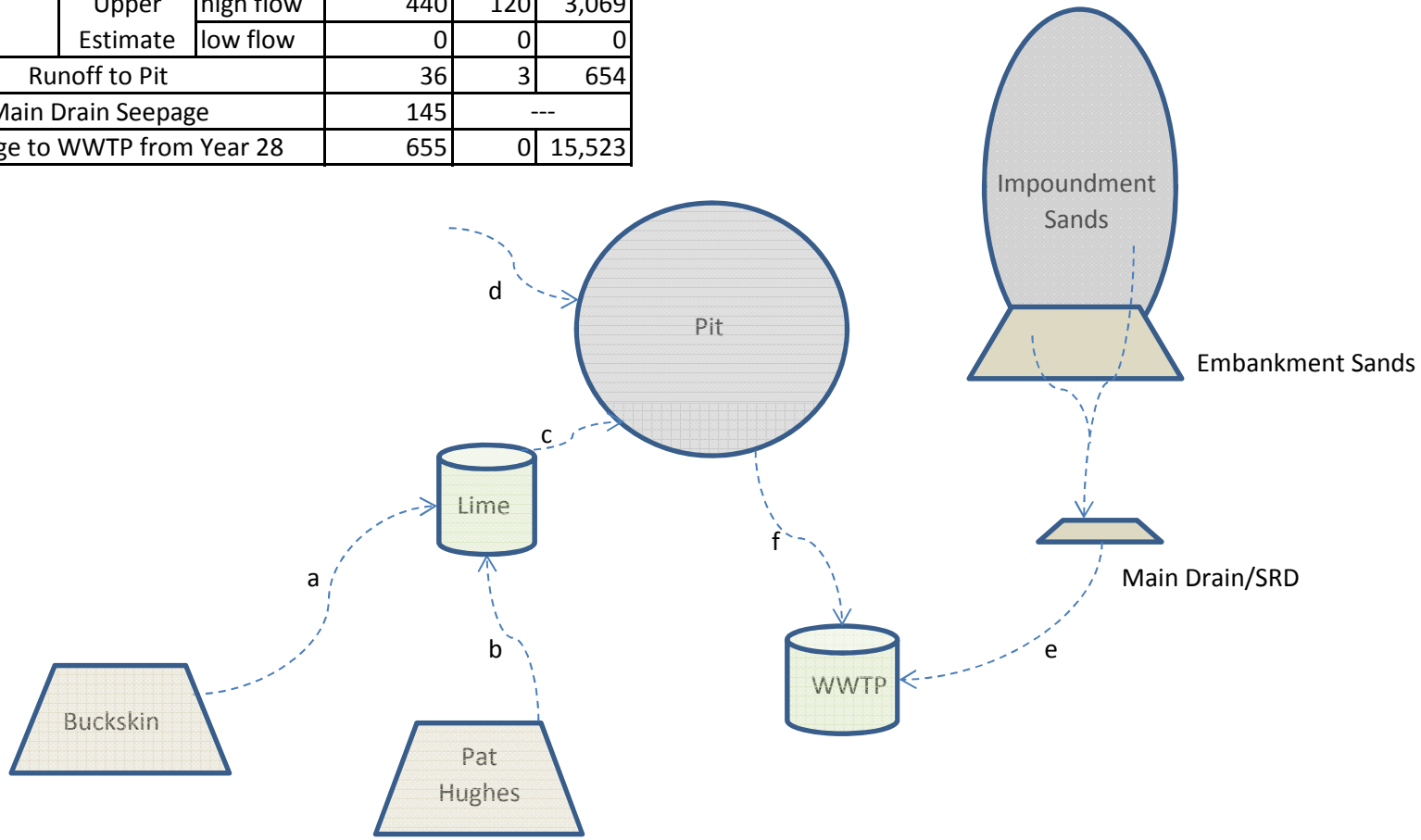


Figure 4.6-8 Alternative M2 water management, years 6-plus.

Table 4.6-19. Thompson Creek water quality, 7Q10 flow, Alternative M2.
all units are µg/L except mg/L for SO_4^{2-}

Parameter[1]	Existing Thompson Creek Receiving Water Quality	Predicted Thompson Creek Water Quality		CMC[2]	CCC[2]
		Best Estimate	Upper Estimate		
SO_4^{2-}	14	27.0	33.8	N/A	N/A
Al	8.8	10.4	209.5	N/A	N/A
As	0.5	0.5	0.6	340	150
Cd	0.05	0.05	0.29	0.71	0.37
Co	0.1	0.11	4.76	N/A	N/A
Cu	0.8	0.84	8.24	8.4	6.0
Fe	30	30	34	N/A	N/A
Pb	0.075	0.08	0.28	28	1.1
Mn	0.48	1.1	236.9	N/A	N/A
Mo	2.07	2.9	3.1	N/A	N/A
Ni	0.46	0.5	0.8	247	27
Se-T	1.95	2.4	2.6	20	5
U	1	1.2	2.9	N/A	N/A
Zn	3	3.2	23.1	62	62

[1] Dissolved metal data were used for all metals except selenium, since the selenium guideline applies to the concentration of total selenium.
[2] CMC/CCC assuming a hardness of 47 mg/L

Of all of the constituents analyzed, only the concentration of copper would slightly exceed a numeric WQS (8.24 µg/L versus CCC_{copper} = 6.0 µg/L), and only for the conservative 7Q10 flow/upper estimate (long-term, infrequent, moderate effect). Regarding antidegradation, all evaluated constituents would be under the 10 percent threshold under all analyzed scenarios except for the low flow/upper estimate – copper, cadmium, selenium, zinc, and lead; the 7Q10 flow/best estimate selenium; and the 7Q10 flow/upper estimate – copper, cadmium, selenium, lead, and zinc (long-term, infrequent, minor effect).

High-flow Conditions

The water management structures would manage water for the same design storms that would be applicable under Alternative M1. The new culvert for the Phase 8 West road would manage at least a 500 year/24 hour storm during mining and reclamation, as would the relocated Pat Hughes sedimentation pond. Water management structures would manage design storms in the

same way and to the same extent as under M1. Therefore, there would be negligible effects to Thompson Creek from sediment delivery (i.e., TSS/turbidity) via Buckskin Creek or Pat Hughes Creek.

TCMC would manage mine-affected water throughout mining, reclamation, and post-reclamation such that the allowable discharges would meet the NPDES permit limits. Accordingly, Outfall 001 and Outfall 002 would continue to be used at times when the water quality from these outfalls would allow for discharge to Thompson Creek. Based upon the NPDES permit compliance history of the mine during the last 10 years, discharges would typically comply with all NPDES permit requirements. However, there could be occasional permit limit exceedances at these outfalls during spring run-off (long-term, negligible to minor effect). The pipeline installed in late 2011 in the lower Buckskin Creek watershed has resulted in improved water quality at the base of the Buckskin WRSF and to Thompson Creek and would be expected to make selenium exceedances at Outfall 001 less likely (the same situation as under Alternative M1) (long-term, minor effect).

S. Creek and Tributaries

Low-flow Conditions

Flow reductions to Bruno Creek would not be expected. However, there would be an increase in the base flow of Redbird Creek for Years 1 to 5 under Alternative M2 due to increased seepage from the higher TSF impoundment (up to ~ 45 gpm compared to ~ 35 gpm for Alternative M1 during mining) (long-term, minor effect on the base flow of either Redbird Creek or S. Creek). For Years 6-plus for both alternatives the seepage would diminish to no flow (no effect).

The water quality of S. Creek during mining would be essentially the same as for Alternative M1. The loads of sulfate and chloride to Redbird Creek from the TSF would continue to increase (by 28 %) during mining, but the effect to S. Creek would be negligible due to dilution of the seepage by both Redbird Creek and S. Creek. Any seepage that would bypass the Bruno Creek collection systems under Alternative M1, would continue only during mining under Alternative M2 (no or negligible effect).

During reclamation the same sources (i.e., impoundment tailings for Years 1 to 5 and embankment sands for Years 6-plus) with the same chemistry would contribute loads to S. Creek, similar to what would occur under Alternative M1. However, for Years 1 to 5 the loads would be 28 percent greater because of the increased flow to Redbird Creek due to increased heads in the TSF driving the seepage. Regardless, the greater loads would have negligible effects to S. Creek, i.e., no additional exceedances of numeric WQSs or antidegradation thresholds (Table 4.6-20. compared to Table 4.6-3.) (negligible effect). There would be no change to the water quality of S. Creek during Years 6-plus (i.e., Table 4.6-4.) except under the conservative 7Q10 flow/upper estimate for cadmium for which the concentration (1.11 ug/L) would be slightly greater than the CCC (0.74 ug/L) (long term, infrequent moderate or major effect).

Table 4.6-20. S. Creek water quality, Years 1-5, Alternative M2.
all units are µg/L except mg/L for SO_4^{2-}

Parameter[1]	Existing S. Creek Receiving Water Quality	Predicted S. Creek Water Quality Low Flow		Predicted S. Creek Water Quality 7Q10 Flow		CMC[2]	CCC[2]
		Best Estimate	Upper Estimate	Best Estimate	Upper Estimate		
SO_4^{2-}	75	88	89	100	102	N/A	N/A
Al	26	26	26	26	26	N/A	N/A
As	0.96	0.98	1.01	1.00	1.06	340	150
Cd	0.05	0.05	0.05	0.05	0.05	1.96	0.74
Co	0.14	0.19	0.19	0.23	0.24	N/A	N/A
Cu	0.53	0.53	0.58	0.53	0.63	26	16.7
Fe	30	56	69	81	107	N/A	N/A
Pb	0.1	0.10	0.10	0.10	0.10	105	4.1
Mn	2.5	52	53	100	103	N/A	N/A
Mo	2.8	2.8	2.8	2.8	2.8	N/A	N/A
Ni	1.3	1.5	1.5	1.6	1.6	686	76
Se-T	1	1.0	1.0	1.0	1.0	20	20/5
U	1	1.1	1.1	1.1	1.1	N/A	N/A
Zn	2.5	2.6	2.6	2.6	2.8	172	173

[1] Dissolved metal data were used for all metals except selenium, since the selenium guideline applies to the concentration of total selenium.
[2] CMC/CCC standards assuming a hardness of 157 mg/L

High-flow Conditions

There would be negligible changes to flood flows/sediment delivery to Bruno Creek, Redbird Creek, or S. Creek.

Pit Lake and Salmon River

The water entering the open pit via precipitation, run-off, and groundwater pathways would continue to be pumped out (dewatered) and used during mining (up to 520 gpm compared to 358 gpm for Alternative M1). The additional water pumped from the pit would reduce the amount of make-up water withdrawn from the Salmon River (negligible effect). There would not be meaningful changes to streamflows in the locality during mining. However, during reclamation the pit would be used to store water collected by the water management system and water would no longer be withdrawn from the Salmon River. Both of these effects would occur under Alternative M1, but would occur 9 years later under Alternative M2. The larger pit (~ 1,000 feet wider and a floor elevation of 6,100 feet compared to 6,350 feet for Alternative M1) would require approximately 70 years after mining ceases to fill to the control level when discharge would begin, instead of approximately 30 years for Alternative M1 (same effect to the hydrologic balance as for Alternative M1, but for an even longer duration).

As with Alternative M1, water directed to the pit would be managed and treated as required to maintain neutral pH conditions in the facility. Although the same sources would contribute to the pit lake, their ratios would be different, such that the concentrations of the constituents in the lake would typically be 30 to 60 percent less than the concentrations for Alternative M1 (Table 4.6-5). Regardless, as with Alternative M1, once the surface of the pit lake reaches the control level, water would be pumped from the pit, treated, and discharged to the Salmon River at Outfall 005 along with other water from the SRD that would be pumped directly to the second treatment plant. The average discharge rate from Outfall 005 would be 945 gpm (2.11 cfs), compared to 914 gpm (2.04 cfs) for Alternative M1 (negligible effect for either low flow or high flow).

The quality of the water discharged from the pit lake via the second treatment plant would be the same as under Alternative M1 (Table 4.6-6). The water quality of the Salmon River downstream of S. Creek would be essentially the same as for Alternative M1 for both low flow (Table 4.6-21. versus Table 4.6-7.) and 7Q10 flow (Table 4.6-22. versus Table 4.6-8). The slight differences would be from the slightly greater discharge rate under Alternative M2 compared to under Alternative M1. However, all numeric WQSs for the Salmon River would be met (negligible effect). Regarding antidegradation, during the 7Q10 flow the concentrations of cadmium and selenium would exceed (or equal to in the case of selenium) the 10 percent threshold (same as Alternative M1).

Surface Water Rights

The BLM water rights to flows in Pat Hughes Creek would be more difficult to use for stockwatering as the Pat Hughes WRSF covers more of the downstream channel. However, such stockwater does not occur now and would not occur in the foreseeable future (negligible effect).

Table 4.6-21. Salmon River water quality, low flow, Alternative M2.
all units are µg/L except mg/L for SO_4^{2-}

Parameter[1]	Existing Salmon River Receiving Water Quality	Predicted Salmon River Water Quality		CMC[2]	CCC[2]
		Best Estimate	Upper Estimate		
SO_4^{2-}	8.6	17.0	17.1	N/A	N/A
Al	10.6	23.4	24.8	N/A	N/A
As	1.57	1.6	1.6	340	150
Cd	0.050	0.06	0.07	0.9	0.43
Co	0.100	0.15	0.18	N/A	N/A
Cu	0.40	0.48	0.56	10.8	7.5
Fe	30.0	31.3	31.3	N/A	N/A
Pb	0.050	0.06	0.06	38	1.5
Mn	1.87	21.4	23.2	N/A	N/A
Mo	2.8	3.1	3.1	N/A	N/A
Ni	0.6	0.70	0.75	312	35
Se-T	1.0	1.2	1.2	20	5
U	2.0	2.2	2.2	N/A	N/A
Zn	3.7	4.2	4.6	78	79

[1] Dissolved metal data were used for all metals except selenium, since the selenium guideline applies to the concentration of total selenium.
[2] CMC/CCC standards assuming a hardness of 62 mg/L

Table 4.6-22. Salmon River water quality,7Q10 flow, Alternative M2.
all units are µg/L except mg/L for SO_4^{2-}

Parameter[1]	Existing Salmon River Receiving Water Quality	Predicted Salmon River Water Quality		CMC[2]	CCC[2]
		Best Estimate	Upper Estimate		
SO_4^{2-}	8.6	36.5	36.8	N/A	N/A
Al	10.6	57.6	62.9	N/A	N/A
As	1.57	1.6	1.6	340	150
Cd	0.050	0.10	0.13	0.9	0.43
Co	0.100	0.28	0.41	N/A	N/A
Cu	0.40	0.65	0.95	10.8	7.5
Fe	30.0	32.7	32.9	N/A	N/A
Pb	0.050	0.07	0.08	38	1.5
Mn	1.87	75.5	82.2	N/A	N/A
Mo	2.8	3.6	3.6	N/A	N/A
Ni	0.6	0.90	1.09	312	35
Se-T	1.0	1.7	1.7	20	20/5
U	2.0	2.6	2.7	N/A	N/A
Zn	3.7	5.3	6.8	78	79

[1] Dissolved metal data were used for all metals except selenium, since the selenium guideline applies to the concentration of total selenium.
[2] CMC/CCC standards assuming a hardness of 62 mg/L

Groundwater

Buckskin Creek Watershed

The footprint of the upper Buckskin WRSF would be larger than under Alternative M1, which would change the ratio of precipitation which falls on and infiltrates the facility relative to the precipitation that falls on the entire watershed, i.e., there would be changes to the quality of the seepage from the facility. The change in volume of infiltration water at the surface water station BuckC, for an average year, would increase the amount of discharge from infiltration by 6 percent. The difference in constituent loads in groundwater to Thompson Creek between Alternative M1 and Alternative M2 would be negligible with the Buckskin Creek cutoff wall in place (Table 4.6-23. In addition to the increased footprint of the Buckskin WRSF, there would also be an increase in the amount of Type 2 (potentially acid-generating) waste rock in the facility. The best estimate assumes the waste rock in the Buckskin Creek WRSF would not become acid generating. The upper estimate assumes the waste rock in the facility would become acid generating, even though such is not expected in either the short-term or long-term.

Table 4.6-23. Loads in groundwater, Buckskin Creek watershed to Thompson Creek, after reclamation.

all units are pounds/day

Parameter	Current[1] Metased. Rock Mean	Alt. M1 Best Estimate	Alt. M1 Upper Estimate	Alt. M2 Best Estimate	Alt. M2 Upper Estimate
SO_4^{2-}	2.72	0.04	3.75	0.042	3.83
Al	0.00006	$5.72x10^{-8}$	0.04416	$5.72 x10^{-8}$	0.05829
As	0.00015	$1.91 x10^{-8}$	$7.62 x10^{-6}$	$1.91 x10^{-8}$	$8.00 x10^{-6}$
Cd	$1.91x10^{-6}$	$9.53 x10^{-9}$	0.00005	$1.14 x10^{-8}$	0.00006
Co	$1.91x10^{-6}$	$3.81 x10^{-8}$	0.00030	$4.00x10^{-8}$	0.00036
Cu	0.00002	$1.14 x10^{-7}$	0.00029	$1.35 x10^{-7}$	0.00030
Fe	0.00057	$7.24 x10^{-7}$	0.00023	$7.24 x10^{-7}$	0.00023
Mn	0.00013	$7.05 x10^{-7}$	0.01924	$8.38 x10^{-7}$	0.02400
Mo	0.00090	0.00001	0.00001	0.00002	0.00001
Ni	0.00001	$1.91 x10^{-7}$	0.00006	$2.29 x10^{-7}$	0.00008
Pb	$1.91x10^{-6}$	$3.81 x10^{-9}$	0.00002	$3.81 x10^{-9}$	0.00002
Se-T	0.00006	$1.12 x10^{-6}$	0.00010	$1.39 x10^{-6}$	0.00012
U	0.00030	$2.86 x10^{-7}$	0.00032	$3.62 x10^{-7}$	0.00040
Zn	0.00004	$7.05 x10^{-7}$	0.00362	$8.57 x10^{-7}$	0.00461

[1] BW2 Mean 2009-2010

Pat Hughes Creek Watershed

In addition to the two cutoff walls discussed previously (Section 4.6.1.1.), a third cutoff wall would be installed below the final toe of the facility. Cutoff Wall #3 would be anchored into competent metasedimentary rock below the higher groundwater recharge zone (where metasedimentary bedrock has greater than average conductivity for the formation). Therefore, only Type 1 (not acid-generating) waste rock would be placed in the space between Cutoff Wall #1 and Cutoff Wall #3 (Figure 4.6-4., Table 4.6-5). Furthermore, as for the Buckskin WRSF, the footprint and volume of the Pat Hughes WRSF would increase affecting the ratio between natural waters and mine-influenced waters. For example, due to the increased size of the facility there would be a larger amount of infiltration through the facility compared to under Alternative M1 and a lesser amount of groundwater from outside the influence of the WRSF. The chemistry of the seepage from the facility has been calculated for both base flow (Table 4.6-24.) and spring snowmelt (Table 4.6-25.) during both mining and reclamation with the cutoff walls in place for both Alternative M1 and Alternative M2.

Table 4.6-24. Pat Hughes WRSF baseflow water quality (PHtoe).
all units are mg/L except s.u. for pH and mg/L $CaCO_3$ for acidity

Parameter	Alt. M1 Mining	Alt. M1 Reclamation	Alt. M2 Mining	Alt. M2 Reclamation	Idaho Groundwater Standard
pH	**4.56**	**4.56**	**4.55**	**4.55**	6.5-8.5[2]
SO_4^{2-}	**1,540**	**1,490**	**1,730**	**1,690**	250[2]
Al	**54**	**52**	**63**	**61**	0.2[2]
As	0.004	0.004	0.004	0.004	0.05[1]
Cd	**0.055**	**0.053**	**0.062**	**0.061**	0.005[1]
Co	0.35	0.34	0.39	0.38	
Cu	0.41	0.41	0.42	0.42	1.3[1]
Fe	0.11	0.11	0.11	0.11	0.3[2]
Mn	**22.6**	**21.9**	**25.6**	**24.9**	0.05[2]
Mo	0.008	0.008	0.008	0.008	
Ni	0.061	0.059	0.069	0.067	
Pb	0.006	0.006	0.006	0.006	0.015[1]
Se-T	0.02	0.019	0.023	0.022	0.05[1]
U	0.36	0.35	0.41	0.40	
Zn	4.3	4.1	4.8	4.7	5[2]
Acidity	341	328	397	385	

[1] primary standard, IDAPA 58.01.11
[2] secondary standard, IDAPA 58.01.11
bold typeface indicates exceeds Idaho Groundwater Standard

Table 4.6-25. Pat Hughes WRSF spring snowmelt water quality (PHtoe).
all units are mg/L except s.u. for pH and mg/L $CaCO_3$ for acidity

Parameter	Alt. M1 Mining	Alt. M1 Reclamation	Alt. M2 Mining	Alt. M2 Reclamation	Idaho Groundwater Standard
pH	**3.65**	**3.88**	**3.58**	**3.79**	6.5-8.5[2]
SO_4^{2-}	**2,220**	**2,050**	**2,300**	**2,108**	250[2]
Al	**83**	**77**	**86**	**79**	0.2[2]
As	0.017	0.011	0.02	0.013	0.05[1]
Cd	**0.081**	**0.075**	**0.084**	**0.077**	0.005[1]
Co	0.51	0.47	0.53	0.48	
Cu	**2.6**	**1.6**	**3.0**	**1.9**	1.3[1]
Fe	**0.57**	**0.36**	**0.67**	**0.42**	0.3[2]
Mn	**33.3**	**30.6**	**34.6**	**31.5**	0.05[2]
Mo	0.009	0.009	0.009	0.009	
Ni	0.09	0.083	0.093	0.085	
Pb	**0.063**	**0.035**	**0.076**	**0.044**	0.015[1]
Se-T	0.03	0.027	0.031	0.028	0.05[1]
U	0.53	0.49	0.55	0.50	
Zn	**6.3**	**5.8**	**6.5**	**6.0**	5[2]
Acidity	535	488	557	503	

[1] primary standard, IDAPA 58.01.11
[2] secondary standard, IDAPA 58.01.11
bold typeface indicates exceeds Idaho Groundwater Standard

Pat Hughes Cutoff Wall #1 and Cutoff Wall #2 would be installed through colluvium and would be anchored in volcanic bedrock (distinct barrier to groundwater flow). Cutoff Wall #3 would be installed through colluvium and would be anchored in the metasedimentary rock (some affected groundwater would bypass the cutoff wall via the relative permeable metasedimentary rock under the wall). All of the constituents in groundwater from the Pat Hughes WRSF were conservatively assumed to reach Thompson Creek (no attenuation or reduction in loading along the groundwater flowpath).

Acidic seepage from the Pat Hughes WRSF mixes with groundwater before reporting as seepage to PHtoe. The ratio of Pat Hughes WRSF infiltration and groundwater seepage fluctuates throughout the year, with the greatest portion of flow being attributed to waste rock infiltration during the beginning of the spring snowmelt. Estimated Pat Hughes pore water (as opposed to PHtoe water which is diluted by groundwater flow) is used during spring melt time points to produce a conservative estimate of loadings (Table 4.6-26., Table 4.6-27).

Table 4.6-26. Pat Hughes WRSF discharge water quality, best estimate.
all units are µg/L except s.u. for pH and mg/L for SO_4^{2-}

Parameter	PW11[1] Metased. Rock	Alt. M1 Water Quality	Alt. M2 Water Quality			Idaho Groundwater Standards
		Cutoff Wall #1 Best Estimate	Cutoff Wall #1 Best Estimate	Cutoff Wall #2 Best Estimate	Cutoff Wall #3 Best Estimate[2]	
pH	7.63	**4.6**	**4.5**	**4.5**	8	6.5-8.5
SO_4^{2-}	245	**1,490**	**1,690**	**1,690**	**1,015**	250[4]
Al	27	**52,000**	**61,000**	**61,000**	1	200[4]
As	8.0	4.0	4.0	4.0	0.7	50[3]
Cd	0.04	**53**	**61**	**61**	0.15	5[3]
Co	1.15	340	380	380	0.4	
Cu	0.15	410	420	420	1.2	1,300[3]
Fe	110	110	110	110	30	300[4]
Pb	0.12	6.0	6.0	6.0	0.05	15[3]
Mn	**170**	**21,900**	**24,900**	**24,900**	1.1	50[4]
Mo	6.0	8.0	8.0	8.0	62	
Ni	2.0	59	67	67	0.8	
Se-T	1.0	19	22	22	34	50[3]
U	9.0	350	400	400	10	
Zn	22.0	4,100	4,700	4,700	5	5,000[4]

[1] mean measured concentrations in groundwater in metasedimentary bedrock at PW11
[2] median measured concentrations at BuckC 2009 to 2010
[3] primary standard, IDAPA 58.01.11
[4] secondary standard, IDAPA 58.01.11
bold typeface indicates exceeds Idaho Groundwater Standard

Table 4.6-27. Pat Hughes WRSF discharge water quality, upper estimate.
all units are µg/L except s.u. for pH and mg/L for SO_4^{2-}

Parameter	Alt. M1 Water Quality Cutoff Wall #1 Upper Estimate	Alt. M2 Water Quality			Idaho Groundwater Standards
		Cutoff Wall #1 Upper Estimate	Cutoff Wall #2 Upper Estimate	Cutoff Wall #3 Upper Estimate[1]	
pH	**3.5**	**3.5**	**3.5**	7.6	6.5-8.5
SO_4^{2-}	**2,460**	**2,460**	**2,460**	**1,120**	250[3]
Al	**93,000**	**93,000**	**93,000**	2	200[3]
As	4.0	4.0	4.0	1.6	50[2]
Cd	**110**	**110**	**110**	0.37	5[2]
Co	2,200	2,200	2,200	0.9	
Cu	**3,500**	**3,500**	**3,500**	4.5	1,300[2]
Fe	**1,400**	**1,400**	**1,400**	40	300[3]
Pb	**94**	**94**	**94**	0.09	15[2]
Mn	**34,600**	**34,600**	**34,600**	9	50[3]
Mo	11	11	11	73	
Ni	100	100	100	7.8	
Se-T	33	33	33	44	50[2]
U	820	820	820	12	
Zn	**9,300**	**9,300**	**9,300**	14	5,000[3]

[1] minimum measured pH and maximum measured concentrations at BuckC during 2009 to 2010
[2] primary standard, IDAPA 58.01.11
[3] secondary standard, IDAPA 58.01.11
bold typeface indicates exceeds Idaho Groundwater Standard

The best estimate (Table 4.6-26.) is based on the estimated average seepage chemistry during baseflow conditions, and the upper estimate (Table 4.6-27.) is based on seepage comprised entirely of pore water with no groundwater dilution (e.g., pH 3.5). The concentrations in these tables represent the quality of the water that would be captured by each cutoff wall (i.e., upstream of the wall). The loads to Thompson Creek were also calculated using the flow that would pass through and around the cutoff walls (Table 4.6-28., Table 4.6-29).

Estimates of the constituent load to Thompson Creek from the Pat Hughes WRSF were calculated as the sum of loadings bypassing all three cutoff walls. The best estimates combined best estimate source chemistry as applicable to each cutoff wall with best estimates of leakage. The upper estimates combined maximum (upper limit) source chemistry with upper estimates of flow bypassing the cutoff walls (based on maximum measured hydraulic conductivity as applicable to each cutoff wall). There would be an order-of-magnitude increase in the total loads to Thompson Creek for most constituents compared to Alternative M1, with much of the increase occurring after reclamation because Cutoff Wall #3 would be anchored in metasedimentary rock rather than volcanic rock (long-term, minor effect). The total loads would be the sums of what would pass around or through the cutoff walls plus what reaches Thompson Creek via the metasedimentary rock.

Table 4.6-28. Loads in groundwater to Thompson Creek from the Pat Hughes watershed, best estimate.

all units are pounds/day

Param.	PW11 Metased. Rock Mean	Alt. M1 Water Quality		Alt. M2 Water Quality				
		Cutoff Wall #1	Total Load	Cutoff Wall #1	Cutoff Wall #2	Cutoff Wall #3	Metased. Rock	Total Load
SO_4^{2-}	32.67	0.08	32.77	0.09	0.36	0.06	135.45	135.83
Al	$3.62x10^{-6}$	0.00290	0.00286	0.00340	0.01311	$5.72x10^{-8}$	0.00013	0.01657
As	$1.07x10^{-6}$	$1.91x10^{-7}$	$1.91x10^{-6}$	$1.91x10^{-7}$	$9.53x10^{-7}$	$3.81x10^{-8}$	0.00010	0.00010
Cd	$3.81x10^{-9}$	$3.05x10^{-6}$	$3.81x10^{-6}$	$3.81x10^{-6}$	0.00001	$7.62x10^{-9}$	0.00002	0.00004
Co	$1.52x10^{-7}$	0.00002	0.00002	0.00002	0.00008	$1.91x10^{-8}$	0.00006	0.00015
Cu	$1.91x10^{-8}$	0.00002	0.00002	0.00002	0.00009	$5.72x10^{-8}$	0.00015	0.00027
Fe	0.00001	0.00001	0.00002	0.00001	0.00002	$1.91x10^{-6}$	0.00400	0.00400
Pb	$1.52x10^{-8}$	$3.81x10^{-7}$	$3.81x10^{-7}$	0.00	$1.91x10^{-6}$	$1.91x10^{-9}$	$7.62x10^{-6}$	$7.62x10^{-6}$
Mn	0.00002	0.00122	0.00124	0.00139	0.00535	$5.72x10^{-8}$	0.00015	0.00686
Mo	$8.00x10^{-7}$	$3.81x10^{-7}$	$1.91x10^{-6}$	0.00	$1.91x10^{-6}$	$3.81x10^{-6}$	0.00827	0.00819
Ni	$2.67x10^{-7}$	$3.24x10^{-6}$	$3.81x10^{-6}$	$3.81x10^{-6}$	0.00002	$3.81x10^{-8}$	0.00011	0.00013
Se-T	$1.33x10^{-7}$	$1.14x10^{-6}$	$1.91x10^{-6}$	$1.91x10^{-6}$	$3.81x10^{-6}$	$1.91x10^{-6}$	0.00453	0.00457
U	$1.14x10^{-6}$	0.00002	0.00002	0.00002	0.00009	$5.72x10^{-7}$	0.00133	0.00145
Zn	$2.97x10^{-6}$	0.00023	0.00023	0.00026	0.00101	$1.91x10^{-7}$	0.00067	0.00194

Table 4.6-29. Loads in groundwater to Thompson Creek from the Pat Hughes watershed, upper estimate.

all units are pounds/day

Parameter	PW11 Metased. Mean	Alt. M1		Alt. M2				
		Cutoff Wall #1	Total Load	Cutoff Wall #1	Cutoff Wall #2	Cutoff Wall #3	Metased.	Total Load
SO_4^{2-}	32.67	11.47	44.2	11.43	44.2	0.99	149.4	206
Al	$3.62x10^{-6}$	0.43339	0.43339	0.43339	1.66973	$1.71x10^{-6}$	0.00027	2.10350
As	$1.07x10^{-6}$	0.00002	0.00002	0.00002	0.00007	$1.33x10^{-6}$	0.00021	0.00030
Cd	$3.81x10^{-9}$	0.00051	0.00051	0.00051	0.00198	$3.81x10^{-7}$	0.00006	0.00253
Co	$1.52x10^{-7}$	0.01025	0.01029	0.01025	0.03943	$7.62x10^{-7}$	0.00011	0.04991
Cu	$1.91x10^{-8}$	0.01631	0.01638	0.01631	0.06287	$4.00x10^{-6}$	0.00061	0.07982
Fe	0.00001	0.00653	0.00648	0.00653	0.02515	0.00004	0.00533	0.03696
Pb	$1.52x10^{-8}$	0.00044	0.00044	0.00044	0.00171	$7.62x10^{-8}$	0.00002	0.00213
Mn	0.00002	0.51968	0.16135	0.16135	0.62122	0.00001	0.00120	0.78372
Mo	$8.00x10^{-7}$	0.00006	0.00006	0.00005	0.00019	0.00007	0.00973	0.01010
Ni	$2.67x10^{-7}$	0.00046	0.00046	0.00047	0.00171	$7.05x10^{-6}$	0.00105	0.00324
Se-T	$1.33x10^{-7}$	0.00015	0.00015	0.00015	0.00057	0.00004	0.00587	0.00667
U	$1.14x10^{-6}$	0.00381	0.00383	0.00382	0.01467	0.00001	0.00160	0.02019
Zn	$2.97x10^{-6}$	0.04343	0.04343	0.04334	0.16688	0.00001	0.00187	0.21222

No Name Creek Watershed

Under Alternative M2 there would be no new facilities or operations in the No Name Creek watershed. Therefore, there would be no effects to groundwater in the watershed.

Open Pit

The effects to groundwater related to the open pit would be the same as for Alternative M1, except more groundwater would be expected to flow away from the lower portions of the pit due to the greater hydraulic head (greater pit depth). Following flooding, the final water level of the flooded pit would be managed and maintained at the same elevation as for Alternative M1.

Bruno Creek Watershed

There would be no substantial changes to the operation of the TSF except the embankment height would increase 112 feet (7,640 feet to 7,752 feet), with a corresponding increase in seepage from the impoundment into Redbird Creek. The increased seepage would contribute slightly greater loads to Redbird Creek during operations (and hence to S. Creek) (Table 4.6-30., with data brought forward from Table 4.6-15.), but there would be negligible effects to S. Creek compared to Alternative M1 (and negligible effects under Alternative M1, Section 4.6.1.2.1).

The best estimate is based on the median measured concentrations, and the upper estimate is based on the maximum measured concentrations.

Table 4.6-30. Loads in groundwater to Redbird Creek and S. Creek from the TSF.
all units are pounds/day

Parameter	Alt. M1 Best Estimate[1]	Alt. M1 Upper Estimate	Alt. M2 Best Estimate[1]	Alt. M2 Upper Estimate
SO_4^{2-}	0.50940	0.54731	0.65456	0.70333
Al	0.00042	0.00168	0.00054	0.00216
As	0.00088	0.00202	0.00114	0.00260
Cd	0.00008	0.00009	0.00010	0.00012
Co	0.00198	0.00211	0.00254	0.00271
Cu	0.00004	0.00211	0.00005	0.00271
Fe	1.07366	1.60401	1.37960	2.06121
Pb	0.00002	0.00002	0.00003	0.00003
Mn	2.05245	2.11341	2.63747	2.71596
Mo	0.00042	0.00042	0.00054	0.00054
Ni	0.00505	0.00547	0.00649	0.00703
Se-T	0.00042	0.00042	0.00054	0.00054
U	0.00253	0.00295	0.00325	0.00379
Zn	0.00211	0.00589	0.00271	0.00757

[1] Best estimate is based on median measured concentrations and upper estimate is based on maximum measured concentrations.

The primary source of seepage water from the TSF would be the 10,000 gpm of tailings slurry, which would occur only during mining and would be the same for all MMPO alternatives. That is, unlike the WRSFs where the primary source of infiltration water would be precipitation, the slight increase in the footprint of the TSF would have negligible effect on seepage from the facility. The facility would be reclaimed in the same manner as for Alternative M1, with the same water management. Hence, the loads in groundwater to Bruno Creek from the embankment seepage bypassing the SRD would be the same except they would occur later than under Alternative M1 (Table 4.6-17). Water from the main drain would continue to be pumped to the pit or directly to the second treatment plant for treatment and discharge at Outfall 005 as required.

Springs

The two Pat Hughes springs would be covered by the expansion of the Pat Hughes WRSF (permanent, major effect to these water resources and BLM water rights).

4.6.1.3. Alternative M3 – No Name Waste Rock Storage Facility

Surface Water

There would be somewhat smaller footprints/volumes for the Buckskin and Pat Hughes WRSFs, but the effects to Thompson Creek from seepage from the Buckskin Creek and Pat Hughes Creek watersheds would generally be the same as under Alternative M2. All surface water in the No Name Creek watershed intercepted by the No Name WRSF would become part of the water management system. The water would probably be discharged to Thompson Creek at a new NPDES outfall at the base of the watershed during mining, but within a few decades after reclamation the water may need to be pumped to the pit for management and/or treatment before discharge to Outfall 005. Hence, the potential effects to Thompson Creek would be 1) reduced run-off from No Name Creek watershed; and 2) seepage from the No Name WRSF that could degrade shallow groundwater discharging to Thompson Creek. Using ratios of watershed areas and calculated flow reductions for the Buckskin Creek watershed and Pat Hughes Creek watershed, there would be a slightly greater decrease in the flow of Thompson Creek compared to Alternative M2 (negligible effect).

It is unknown to what extent drains, cutoff walls, or other mechanisms would capture seepage from a WRSF in the No Name Creek watershed. However, it would be reasonable to expect similar effects to groundwater quality as have occurred at the Buckskin and Pat Hughes WRSFs, which would cause additional effects to the water quality of Thompson Creek (long-term, minor to moderate effect).

Because the TSS data indicate that TCMC has been generally successful at controlling sediment delivery downstream of the existing WRSFs, it is reasonable to assume the same would occur for the No Name WRSF. Therefore, effects due to TSS would be the same as under Alternative M2, with a somewhat greater probability of exceedances of the NPDES permit limit for TSS (long-term, infrequent, minor effect).

Water Rights

The effects to water rights would be the same as for Alternative M2.

Groundwater

The groundwater in the No Name Creek watershed would remain pristine under Alternative M1 and Alternative M2, so any effects under Alternative M3 would represent the loss of a clean water input to Thompson Creek. The mixture and composition of the Type 1 and Type 2 waste rock that would be deposited in a No Name WRSF would determine the quality of the seepage from infiltration through the WRSF. However, based on the extensive observation and analysis of seepage from the Pat Hughes and Buckskin WRSFs, it is highly unlikely the seepage from the No Name WRSF would be pristine. If the seepage would be captured and treated, there would still be less pristine water input to Thompson Creek. Even if the seepage would meet NPDES standards and be discharged to Thompson Creek, the seepage would degrade water quality in Thompson Creek. Therefore, infiltration through a No Name WRSF would probably affect groundwater quality during mining and after reclamation (long-term, moderate effect).

Springs

It is unknown if there are any springs in the No Name Creek watershed, but any such springs would be covered by the No Name WRSF (permanent, major effect to BLM water rights if springs were present).

4.6.2. Land Disposal Alternatives

4.6.2.1. Alternative L1 – No Action

Once the offered lands were sold by TCMC, a new owner may develop or otherwise manage these lands in a way that water use or water quality could be altered, e.g., developing the property adjacent to the Salmon River into residential lots. Such development would have the potential to degrade surface water quality from disturbance of the land surface and groundwater quality from use of new septic systems. However, it is not possible to predict water quantity or quality changes resulting from land ownership changes, other than to assume compliance with all relevant regulations. In particular, it is assumed that water rights associated with the ranch would also be sold along with the land. It is further assumed that the new owner would put these water rights to similar beneficial use at similar quantities. If so, there would be no related change to water quantity. However, the condition of Lyon Creek would remain the same, e.g., there would be a dam/pond in lower Lyon Creek with relatively sparse riparian vegetation, a relatively large number of vehicle fords, little pool habitat, and distinct streambank erosion/sloughing.

4.6.2.2. Alternative L2 – Land Exchange Proposal

There would be negligible effects to water resources associated with the selected land, e.g., the Thompson Creek and S. Creek Conservation Easement would prevent any substantial disturbance along the Thompson Creek riparian corridor; there would be no subdivision/residential development along the S. Creek riparian corridor; and no effects to the S. Creek corridor are reasonably foreseeable (Figure 2.2-1). All of the irrigation and stockwatering water rights associated with the Broken Wing Ranch would be transferred to the US, but there would be no change to the volume or rate of flow for these water rights. The two parcels conveyed to Custer County would continue to be able to use groundwater for domestic purposes without a permit pursuant to 42 Idaho Statutes 111, 227.

Under the BLM management strategies, features such as a campground or boat launch could be constructed on the ranch. Sediment input to the Salmon River from these facilities would be minimal because of implementation of appropriate BMPs during construction, as well as appropriate control measures to minimize soil and bank erosion potentially caused by increased human use (negligible effect). Resting BWR-1 from grazing would reduce sediment input into the Salmon River (negligible effect).

The BLM would work to maintain more instream flow in Lyon Creek, but the amount of such flow is unknown. Under the Lyon Creek conceptual restoration plan, the Lyon Creek dam/pond would be removed, the vehicle fords would be consolidated, and the lower 1,850 feet of the channel would be restored to a more natural flow with less erosion/streambank sloughing (long-term, moderate effect). Adherence to standard sediment and erosion control BMPs would result in negligible effects from sediment and erosion during the restoration work. The irrigated

fields would typically be fertilized every few years and there would be no annual application of herbicides or insecticides to the fields, i.e., the Salmon River would not receive meaningful amounts of fertilizer (nitrate), herbicide, or insecticide run-off (negligible effect) (Redick, P. 2014). Spot herbicide treatments would occur (e.g., along roads) as necessary to comply with State laws and regulations, and would be in accordance with the BLM Challis Field Office integrated weed control program (BLM 2009a).

Under Alternative L2-B there would be no cattle using BWR-1 or the gated crossing of the Salmon River, which would reduce the amount of fecal coliform bacteria and sediment in Lyon Creek and the Salmon River (long-term minor effect for Lyon Creek, negligible effect for the Salmon River). Motorized use of the Lyon Creek ford (infrequent administrative access for BLM) would contribute negligible amounts of sediment to Lyon Creek. Motorized use of Lyon Creek Road (by the public) would not contribute any meaningful sediment to Lyon Creek. There would be no fertilizer run-off from the irrigated fields (negligible effect). All of the irrigated fields would be sprayed with herbicide in the first year of the vegetation conversion, and would receive aggressive spot herbicide applications during the next few years. In addition, other areas of the ranch (e.g., roads) would receive spot herbicide treatment. However, all such vegetation treatments would be in accordance with the BLM Challis Field Office integrated weed control program (negligible effects). The BLM would transfer the water rights associated with the ranch for irrigation (15.89 cfs) and stockwater (0.24 cfs) into a water bank for subsequent conservation, lease, or sale pursuant to State laws, the FLPMA, and approval by the IDWR (negligible effect). The lower portion of Lyon Creek would have an additional 6.22 cfs of flow during the growing season (long-term, moderate effect) (Section 3.6.2). There would not be any effect to water resources associated with the Garden Creek property.

4.6.2.3. Alternative L3 – Land Sale

The effects to water resources on the selected land would be the same as for Alternative L2. There would not be any effect to water resources on the offered lands.

4.6.2.4. Alternative L4 – Reduced Area Land Exchange, Fee Simple

The effects to the selected land would be the same as under Alternative L2. Note that a shorter length (500 feet) of the S. Creek riparian corridor would leave Federal jurisdiction compared to Alternative L2 or Alternative L3 (2,500 feet) (Figure 2.2-1). However, the area of the S. Creek corridor leaving Federal jurisdiction could not be subdivided or residentially developed due to the Thompson Creek and S. Creek Conservation Easement, and no effects to the corridor are reasonably foreseeable. The effects to the offered lands would be the same as under Alternative L2, unless portions of the Broken Wing Ranch were removed to achieve equal valuation. Depending on the subparcels removed, not all of the RAC recommendations would be implemented and the effects to water quality on the Broken Wing Ranch would not occur. In the case of water quality, these changes were negligible, and therefore eliminating them would be a negligible effect. If the water rights associated with the Lyon Creek subparcel were eliminated from the transaction, there would be no effect on water quantity in Lyon Creek or the Salmon River.

4.6.2.5. Alternative L5 – Reduced Area Land Exchange, Easement

The effects would be the same as under Alternative L4, e.g., all of the S. Creek riparian corridor that would leave Federal jurisdiction would be subject to the conservation easement on the 1,500 acres and/or the Thompson Creek and S. Creek Conservation Easement.

4.7. Wildlife Resources

4.7.1. MMPO Alternatives

4.7.1.1. Alternative M1 – No Action

There would be no additional surface disturbance. Consequently, there would be no reduction or fragmentation of habitat for wildlife and special status terrestrial wildlife species, e.g., no effects to big game winter range, wildlife migration habitat/corridors, or any potential uptake of chemicals of potential concern by wildlife. There also would be no displacement of wildlife due to noise, and there would be no change to water quantity that would meaningfully affect wildlife (Section 4.6).

Regarding water quality, the predicted rare (late reclamation/7Q10 flow/upper estimate only), slight cadmium exceedance (1.11 µg/L versus $CCC_{cadmium}$ = 0.74 µg/L for a few days; no exceedance of the CMC) in S. Creek (Section 4.6.) would have a negligible effect on wildlife. This concentration would be below even the conservative concentration for long-term exposure to fish of 3 µg/L above which adverse effects could be either pronounced or probable. However, mammals and birds are comparatively resistant to the biocidal properties of cadmium (Eisler 1985a). Furthermore, the effects of cadmium to biological organisms is reduced by the presence of other metal ions such as zinc (Zn^{2+}), magnesium (Mn^{2+}), and chromium (Cr^{3+}) (e.g., Young 1991, ATSDR 2012). A more recent risk assessment study specific to mine-affected water including a pit lake determined the "no observed adverse effect level" (screening concentration) for chronic exposure for cadmium in water consumed by wildlife to be 4,130 µg/L for mammals and 6,230 µg/L for birds (Integral 2007, Table 4.7-1). These screening concentrations would be three orders of magnitude greater than the maximum concentrations of cadmium that would ever occur in S. Creek. The study is based on or supported by extensive scientific research including Eisler (e.g., 1985a, 1985b, 1988a, 1988b, 1993, 1998), the EPA (1993), and Sample et al. (1996).

Bioaccumulation of cadmium in aquatic life over time would be expected, e.g., wildlife ingesting certain aquatic plants or animals that preferentially uptake cadmium. However, the effects of cadmium bioaccumulation in wildlife would be negligible primarily because the screening concentrations (Integral 2007), which are orders of magnitude above the predicted concentrations of cadmium in S. Creek, include the potential effects of bioaccumulation. In addition, no studies are known that evaluated cadmium bioaccumulation from drinking water with concentrations of cadmium less than 20 µg/L (which is far greater than what might occur in S. Creek).

After reclamation, as the pit lake develops, there would be new migratory bird habitat created by the accumulating water in the pit. Raptors, songbirds, or waterfowl traveling within a few miles of the lake would be expected to use the lake at least occasionally for resting or foraging since there are few lakes in the area. Overall, migratory bird populations using the mine site may

increase due to the additional surface water habitat. The regular use and colonization of the lake and surrounding habitats by birds would depend on the physical characteristics of the lake that would develop over decades (e.g., depth of "shore," lake turnover); the quality and quantity of vegetation that would emerge around the pit margin; and the diversity of colonizing macroinvertebrate organisms (long-term, minor effect, i.e., effects to individuals and not populations).

The pit lake would have high concentrations of several metals relative to natural water bodies (Table 4.6-5). However, all of the concentrations of constituents of potential concern (metals) in the lake would be at least two orders of magnitude below the screening concentrations for wildlife drinking the pit lake water (Integral 2007).

Table 4.7-1. Pit lake water chemistry compared to screening concentrations.
all units are µg/L

Parameter	Alt. M1	Alt. M2	Birds	Mammals
As	5.2	3.5	22,000	290
Cd	12	8.5	6,230	4,130
Cu (III/IV)	160	99	202,000	65,000
Fe	390	290	--[1]	--[1]
Mn	7,300	5,500	4,284,000	377,000
Mo	400	250	15,000	600
Ni	19	13	333,000	171,000
Pb	10	7.4	4,860	34,000
Se-T	20	20	2,150	860
Zn	730	450	62,000	685,000

[1] No screening concentrations were established for iron as iron is not typically found in water in concentrations that are a concern to birds or mammals (Integral 2007).

The most sensitive species (e.g., macroinvertebrate organisms living within the water) would be affected by the pit lake water. However, a direct relationship between the effects to aquatic macroinvertebrate organisms and birds would be improbable. Bioaccumulation of metals in birds via ingestion of lower organisms in the pit would be improbable because these organisms (e.g., macroinvertebrate organisms and plants) would not be expected to occur at or in the pit at levels that would be attractive to birds, and thus birds would not be expected to use the pit for foraging. Therefore, there would be no effects to wildlife (birds or mammals) from the pit lake, even from bioaccumulation. There would also be no effects to wildlife from ingesting soil as none of the soil at the mine would contain elevated concentrations of metals due to mining activity, i.e., greater than the BLM risk management criteria (the concentrations at which further study may be warranted) which for cadmium is 15,000 µg/kg for cattle, 3,000 µg/kg for mule deer, and 300 µg/kg for robins (BLM 2004).

Wildlife would be expected to drink occasionally from the collection facilities for drainage from the WRSFs and the TSF, as there are no structures to prevent wildlife access in these areas. Water sources for wildlife are available along Thompson Creek, along S. Creek, at Twin Apex Creek (less than one mile south of the SRD), and at Upper Bruno Creek at the north end of the TSF, so wildlife would not be expected to use the WRSFs, TSF, or SRD ponds regularly for drinking water due to a lack of other water sources. Although water in the WRSFs, TSF, and SRD will be acidic with elevated concentrations of constituents over the long-term (e.g., Table 4.6-16) none of the maximum concentrations exceed the screening concentrations for birds or mammals listed in Table 4.7-1 (which, as stated previously, include factors for bioaccumulation; Integral 2007). Therefore, even regular use of the WRSFs, TSF, and SRD collection ponds for drinking water would not result in adverse effects to wildlife over the long term.

The main noise sources at the mine that could affect wildlife would continue to be from equipment operation, traffic, and human presence (Section 3.10., Section 4.10). Most wildlife would continue to avoid noise, but some individuals would remain, or return, and become habituated to noise. Mule deer, for example, have habituated to noise at the mine; they would continue to be common even adjacent to the main access road or taking shelter under stationary heavy equipment that is not being operated.

Biological surveys would continue to be conducted during the nesting season in areas planned for disturbance to identify any active nests for bird species. Avoidance plans would be developed as necessary to prevent nest abandonments as a result of noise and human presence in the disturbed areas. Some residual, direct effects to migratory birds may occur if disturbance of these areas is necessary during the nesting season. Should any nests occur in the analysis area, they would likely be abandoned due to noise (short-term, minor effects). However, unintentional take is not expected, and if it occurs, would not have any meaningful effect on populations of migratory birds. Douglas-fir and sagebrush scrub habitats planned for disturbance are generally prevalent across the landscape, and only a miniscule amount of riparian habitat would be affected under any of the MMPO alternatives.

The same amounts and patterns of traffic would occur during mining and reclamation for all of the MMPO alternatives, except the duration of the effects would be approximately 10 years longer for Alternative M2 and Alternative M3. An (indirect) effect of all of the MMPO alternatives would be wildlife injured or killed by TCMC traffic, primarily on SH 75 between the S. Creek Bridge and US Highway 93. An estimated 25 to 50 deer, several elk and bighorn sheep, approximately 100 smaller mammals such as coyotes and rabbits, and a few hundred birds are estimated to be killed each year by all collisions with vehicles on this section of SH 75 (Zwetzig 2012). Mine-related traffic (mostly between 5:00 am and 7:00 am and 5:00 pm and 7:00 pm during shift changes) would comprise approximately 40 percent of the traffic on this section of SH 75 (Section 3.16.) and much of the mine-related traffic would occur during twilight/peak periods for animal movement. Mine-related traffic would also comprise approximately 10 percent of the traffic on US Highway 93 between Challis and the junction of SH 75 with US Highway 93, and an even smaller percentage of the traffic on US Highway 93 between Challis and Salmon (Section 3.16). Therefore, the mine-related traffic would continue to cause proportional wildlife mortality on US Highway 93.

4.7.1.2. Alternative M2 – MMPO as Submitted by TCMC

Timber would be harvested and the understory would be gradually removed (buried by the WRSFs or inundated by the TSF). Therefore, the effects to wildlife from decreased forest habitat would occur at the beginning of mining, whereas the effects to wildlife from decreased understory habitat would occur gradually during mining (over ~ 10 years). Fragmentation of habitat would not increase for any wildlife species because the mine disturbance would be extensions of current disturbance, i.e., currently usable habitat adjacent to the mine would be reduced in size but no new discontinuities or isolation of patches in the habitat would be created (negligible effect). The effects from habitat disturbance to special status terrestrial wildlife species are described below (Table 4.7-2.) followed by the effects to general wildlife.

Table 4.7-2. Effects to special status terrestrial wildlife species.

Species	Occurrence in MMPO area	Effects
MAMMALS		
Canada lynx	**Possible** (movement only)	There would be less (391 acres) forested habitat that lynx could use for moving through the analysis area. The habitat for lynx would be marginal because it would be adjacent to the mine. After reclamation there would be mostly open, shrub-dominated habitat in the disturbed areas, which is not preferred lynx habitat. However, the decrease and modification to lynx habitat would not result in a meaningful change to the movement patterns of any lynx that may move through or near the analysis area (negligible effect).
Gray wolf	**Likely** (movement, temporary cover, and foraging)	There would be less (458 acres) habitat that could be used by gray wolves for foraging as well as movement, temporary cover, or temporary denning. After reclamation there would be mostly open, shrub-dominated habitat in the disturbed areas, which would be suitable for foraging if prey are present. The disturbed habitat would be adjacent to the mine, so there would not be any substantial modifications to the movement areas or foraging opportunities in the analysis area for gray wolves. Habitat for gray wolf exists in the S. Creek and Thompson Creek watersheds adjacent to the disturbance that would occur. These habitats could be used in place of the disturbed habitats. Effects to gray wolf would be on the scale of a few individuals that may occur near the mine. Wolf packs would not be affected by this decrease and the modification of habitat (long-term, minor effect).

Species	Occurrence in MMPO area	Effects
American pika	**Present** (observed in WRSFs)	Pikas were observed in the analysis area at lower elevations than the species usually occurs (> 8,000 feet) in the WRSFs. Pika habitat created by the WRSFs would increase slightly during mining (~ 10 years), after which reclamation would render the habitat unsuitable for pikas. Rock habitat for pikas, in the form of WRSFs, would decrease over the long term. The lower Buckskin WRSF, where one pika was observed, would not be covered until the end of mining (long-term, moderate effect). It is possible that reclamation targets for rocky slope habitat (which would include moderate to steep rock or talus slopes with varying boulder sizes vegetated with grasses, legumes, and low shrubs) would provide some habitat for pikas. Such reclaimed habitat would be available in the long term.
Bighorn sheep	**Possible** (movement, temporary cover, and foraging)	There would be less (458 acres) habitat for bighorn sheep. The disturbed area is not known winter or summer habitat used by bighorn sheep. The potential habitat would be adjacent to the mine. Any bighorn sheep that are known to utilize this habitat could instead utilize adjacent habitat. Some bighorn sheep would also be expected to habituate to mining disturbances. Effects to bighorn sheep from decreases in habitat and possible displacement would be on the level of a few individuals that may utilize the analysis area or move through the area in the future (long-term, minor effect).
Fisher	**Possible** (movement and foraging)	There would be less (391 acres) forested habitat for fishers in the long term, as reclamation would cause a more open, shrub-dominated habitat in most areas, which would be unsuitable for fishers. Because the disturbed habitat would be adjacent to the mine, the decrease and modification of the habitat would reduce the available area for fishers to hunt and forage (as opposed to denning). These effects would be on the scale of individuals (long-term, minor effect).
Spotted bat	**Possible** (roosting and foraging)	There would be a small decrease (< 0.01 acre) in riparian habitat that could be used by spotted bats for foraging. No potential roosting sites (rock outcrops) for spotted bats would be disturbed. The decrease in foraging area would have a negligible effect on spotted bats, as only a few individuals may be affected.

Species	Occurrence in MMPO area	Effects
Pygmy rabbit	**Possible** (in microhabitat patches)	There would be less (62 acres) sagebrush habitat as a result of the expansion. However, areas of disturbance are not likely to contain microhabitat patches suitable for pygmy rabbit as soils in these areas are too rocky. The sagebrush areas most likely to contain microhabitat patches for pygmy rabbit (eastern part of the S. Creek watershed) would not be disturbed (negligible effect).
Townsend's big-eared bat	**Possible** (roosting and foraging)	There would be a small decrease (< 0.01 acre) in riparian habitat that could be used by Townsend's big-eared bats for foraging. No potential roosting or hibernacula sites for Townsend's big-eared bats (rock outcrops, caves, or abandoned mines) would be disturbed. The decrease in the riparian foraging habitat would have a negligible effect on Townsend's big-eared bats, as only a few individuals may be affected.
Wolverine	**Possible** (movement only)	There would be less (458 acres) mostly forested habitat that could be used by wolverines for movement, temporary cover, and foraging. Disturbed areas would probably not be used for denning due to their proximity to the mine. The decrease in habitat would not substantially modify any movement or foraging opportunities for wolverines. If any individuals currently utilize the habitat that would be disturbed, the individual would instead use adjacent habitat that would not be undisturbed. After reclamation the habitat would be largely unsuitable for wolverines due to its openness and proximity to the mine. The potential displacement of wolverines and decrease of habitat would be on the scale of individuals that may utilize the area near the mine for foraging or movement. Overall, wolverine populations would not be affected because wolverines utilize large home ranges and avoid human disturbances in general (long-term, minor effect).
BIRDS		
Greater sage-grouse	**Unlikely**	There would be less (62 acres) sagebrush habitat as a result of the expansion. However, this habitat is not likely to be occupied by sage-grouse and no individuals would be directly affected. There would be no indirect effects from habitat loss because the disturbance area is not considered important sage-grouse habitat according to the latest science-based and interagency collaboration (BLM 2012c) (negligible effect).

Species	Occurrence in MMPO area	Effects
Bald eagle	**Possible** (foraging only)	There would be less (458 acres) potential foraging area for bald eagles. No potential roosting trees along water bodies or creeks would be disturbed. The decrease in the foraging habitat would not be meaningful to bald eagle individuals and thus would have a negligible effect on bald eagles that may be migrating through the area or roosting along the Salmon River or S. Creek. A bald eagle nest occurs next to S. Creek Road which is used by mine-related (and other) traffic. The nest was first recorded in 2009 and was active; therefore, the bald eagles that established and occupy the nest were accepting of the traffic on S. Creek Road. There would be no change to the amounts or patterns of the traffic, but the mine-related traffic would occur for approximately 10 years more (negligible effect).
Boreal owl	**Possible** (nesting and foraging)	There would be less (391 acres) forested habitat for boreal owl nesting and foraging. After reclamation there would be a more open, shrub-dominated habitat in most areas, possibly with scattered conifer trees, which would not be suitable foraging habitat for boreal owls. Because the areas to be disturbed would be close to the mine, it is improbable the disturbed habitat is being used for nesting. Thus, the decrease and modification of habitat would result in a reduction of potential foraging habitat that would affect boreal owl individuals that may be nesting outside of the analysis area (long-term, minor effect).
Brewer's sparrow	**Possible** (nesting)	There would be less (62 acres) sagebrush habitat suitable for nesting brewer's sparrows. In the long term the reclaimed areas would resemble the open, shrub-dominated or grassland habitats that were suitable for nesting brewer's sparrows (negligible effect).
Calliope hummingbird	**Possible** (nesting)	There would be less (391 acres) forested habitat for calliope hummingbird nesting. After reclamation there would be more open, shrub-dominated habitat in most areas at the mine, eventually with scattered conifer trees. Some new forest edge habitat would provide suitable nesting habitat for calliope hummingbirds. The decrease and modification of nesting habitat would be on the scale of individual hummingbirds that may use the analysis area (long-term, minor effect).

Species	Occurrence in MMPO area	Effects
Flammulated owl	**Likely** (nesting and foraging)	There would be less (391 acres) forested habitat for flammulated owl nesting and foraging. After reclamation there would be more open, shrub-dominated habitat in most areas, some of which may be suitable foraging habitat for flammulated owls. It is unlikely that the forest habitat to be disturbed contains dense enough stands for nesting; therefore, disturbance would only reduce potential foraging habitat for flammulated owls (long-term, minor effect).
Great gray owl	**Possible** (nesting and foraging)	There would be less (391 acres) forested habitat for great gray owl nesting, and there would be less (5 acres) grassland that may provide foraging habitat. After reclamation there would be more open, shrub-dominated habitat in most areas, possibly with scattered conifer trees, which could be suitable foraging habitat for great gray owls. The decrease and modification of forested habitat would affect any great gray owl individuals that may be nesting in the vicinity of the analysis area (long-term, minor effect).
Hammond's flycatcher	**Possible** (nesting)	There would be less (391 acres) forested habitat for Hammond's flycatchers. After reclamation there would be more open, shrub-dominated habitat in most areas, which would no longer be suitable nesting habitat for this species. The decrease in nesting habitat would affect only individuals that may use the analysis area (long-term, minor effect).
Northern goshawk	**Possible** (nesting and foraging)	There would be less (391 acres) forested habitat for goshawk nesting and foraging. After reclamation there would be more open, shrub-dominated habitat in most areas, possibly with scattered conifer trees, which would no longer be suitable for nesting. The decrease and modification of forested habitat would affect any goshawk individuals that may be nesting in the vicinity of the analysis area and would not affect goshawk populations (long-term, minor effect).
Olive-sided flycatcher	**Possible** (nesting)	There would be less (391 acres) forested habitat for olive-sided flycatchers. After reclamation there would be more open, shrub-dominated habitat in most areas, which would not be suitable nesting habitat. The decrease in nesting habitat would affect only the few individuals expected to use the area (long-term, minor effect).

Species	Occurrence in MMPO area	Effects
Peregrine falcon	**Possible** (foraging only)	There would be less (458 acres) potential foraging area for peregrine falcons. No potential nesting sites would be disturbed. There would be negligible effects to individual peregrine falcons that may migrate through the area or nest along the Salmon River.
Pileated woodpecker	**Possible** (nesting)	There would be less (391 acres) forested habitat for pileated woodpeckers. Any pileated woodpeckers in the disturbed areas would be displaced. The decrease of habitat and potential displacement would affect only the few individuals expected to use the area (long-term, minor effect).
Three-toed woodpecker	**Possible** (nesting)	There would be less (391 acres) forested habitat for three-toed woodpeckers. Any individuals in the disturbed areas would be displaced. The decrease in habitat and potential displacement would affect only the few individuals expected to use the area (long-term, minor effect).
Willow flycatcher	**Possible** (nesting)	There would be a small decrease (< 0.01 acre) in riparian habitat. The decrease would not meaningfully affect any individuals.
Williamson's sapsucker	**Possible** (nesting)	There would be less (391 acres) forested habitat for Williamson's sapsuckers. Any individuals in the disturbed areas would be displaced. The decrease in habitat and potential displacement would affect only the few individuals expected to use the area (long-term, minor effect).
REPTILES AMPHIBIANS		
Columbia spotted frog	**Possible**	There would be a small decrease (< 0.01 acre) in riparian habitat. The decrease in potential habitat would not affect any Columbia spotted frogs that may use the aquatic habitats in the analysis area.

General Wildlife

There would be less (458 acres, mostly forested) general wildlife habitat available for movement, temporary cover, denning, and foraging. However, the habitat would be adjacent to the mine so there would probably not be any essential movement areas in the habitat, or any substantial modifications to wildlife movement in the analysis area. Species such as small mammals and game animals that currently utilize undisturbed habitat adjacent to the mine would continue to utilize such habitat. In the short term (1-10 years) and the long-term (> 10 years) there would be less conifer forest available for temporary cover and denning, but after reclamation there would be open, shrub-dominated habitats available for foraging and movement areas. In the long term much of the mine (except the open pit) would be conifer forest habitat. Considering the amount of habitat available for general wildlife in the analysis area, there may be a small, detectable effect to individuals from the decrease and modification of habitat, as individuals who use these areas would be displaced into adjacent habitat. There would be no effects to the population viability of any wide-ranging species (long-term, minor effect).

All of the habitats that would be disturbed would be potentially used for migration by big game (deer, elk, and possibly bighorn sheep). However, there would be no major migration corridors in the disturbed areas. In addition, the habitat to be removed would be adjacent to the mine and there would be abundant undisturbed (and eventually reclaimed) habitat, e.g., there would be migration routes around obstacles such as the open pit or the steep faces of the WRSFs. Therefore, there would not be substantial modifications to migration patterns in the analysis area (negligible effect).

There would be less (391 acres) suitable habitat for forest species in the short term and long term. Considering the amount of habitat for forest species in the analysis area, the displacement of forest species into adjacent suitable habitats would affect some individuals that may use the area but would not have a detectable effect on the viability of any population (long-term, minor effect).

There would be less (62 acres) sagebrush habitat and less (5 acres) grassland during mining, but after reclamation most of the disturbed area would be open, shrub-dominated or grassland habitats, and eventually conifer forest. These habitats would be available as foraging habitat for raptors and nesting habitat for other migratory bird species. Reclamation targets for mule deer and elk winter range would be to provide flat to moderately sloping areas with a mix of grasses, forbs, shrubs, and conifer trees in patches which would provide suitable habitat for migratory birds. Grassland/shrub habitat is very common in the analysis area, thus there would be much undisturbed grassland/shrub habitat adjacent to or near the mine. Only some individuals that may use the disturbed areas would be affected, and the gradual nature of the disturbance to the understory would provide opportunity for these individuals to move if necessary and avoid direct effects (short-term, minor effect).

The amount of aspen riparian habitat is declining in the BLM Challis Field Office area, and the structural diversity of many riparian habitats in general is declining due to decreases in shrubs, trees, and herbaceous species that maintain function. However, there would be only a small decrease (< 0.01 acre) in the riparian habitat (negligible effect).

A total of 496.6 acres would be disturbed (including developed or barren areas with no vegetation), with 57 percent of the disturbed area in mule deer winter range and 69 percent in elk winter range. There would be no crucial winter range in the MMPO area. After reclamation the same area of winter range for mule deer and elk would be available. There would be no change to population numbers or growth rate due to the decrease in winter range habitat and capability. Mule deer and elk are very common and visible in disturbed areas of the mine, and regularly use the modified habitat and tolerate proximal human activity. Therefore, there would not be effects at the population level. In addition, there would be adequate winter range habitat available in areas adjacent to the mine, which would not require substantial modification of movements or behavior for mule deer or elk to access (long-term, minor effect).

Unintentional, incidental take of migratory birds during habitat removal may occur. Timber harvest, power line relocation, and pipeline construction would be the most likely activities to result in a minor amount of unintentional take. Most new disturbance would occur adjacent to existing disturbance and would occur gradually. Avoidance measures would be implemented as part of environmental controls (Section 2.1.1.7.) to avoid affecting nesting birds. Unintentional take, occurring when active nests are either not found during surveys (i.e., disturbed unintentionally), or cannot be avoided, would be a short-term, minor effect and would not have any measurable effects on migratory bird populations. The habitats that would be disturbed (sagebrush scrub and Douglas-fir forest) are abundant in the surrounding areas. This gradual mode of disturbance would allow any birds present to leave the area and avoid direct effects.

Other

In general there would be the same effects to wildlife from water quality, noise, and chemicals of potential concern (long-term, negligible to minor effects). The magnitudes and durations of these effects would not change due to their timing, i.e., mining would continue for approximately 10 years more compared to Alternative M1, and the pit lake would require approximately 70 years instead of 30 years to reach the control level (but a small lake would be present within a year or two after the end of mining). There would be a slightly lower concentration of metals in the pit lake (Table 4.7-1.) (negligible effect).

4.7.1.3. Alternative M3 – No Name Waste Rock Storage Facility

There would be greater disturbance (32 %) compared to under Alternative M2, with 234 acres of new disturbance in the No Name Creek drainage. Habitat in the drainage would be sloped, sometimes steeply, and covered with sagebrush, scattered rocky outcrops, and isolated conifer trees. The habitat would probably be foraging habitat for raptors and nesting habitat for other migratory bird species. General wildlife (wide-ranging species) would not be expected in the drainage since the upstream end of the canyon would be blocked by steep walls and would contain the mine operations.

The effects would be to individuals and not local populations. Any raptors that use the No Name Creek drainage as foraging habitat would forage elsewhere, and there would be adequate similar (undisturbed) habitat in the analysis area such that raptors would not be displaced from the analysis area. In addition, the affected habitat would not be of high value due to the proximity of

the mine. Migratory birds may be displaced into adjacent habitat for nesting; however, there is adequate similar habitat in the analysis area (long-term, minor effects).

There would be less wildlife habitat disturbance in the Buckskin Creek drainage (~ 50 acres) and Pat Hughes Creek drainage (~ 30 acres) compared to under Alternative M2. Relative to Alternative M2, the undisturbed portions of the Buckskin Creek drainage would be mostly steep hillsides with relatively open forest and grassy understory, which would provide some habitat for migratory birds adjacent to the existing mine. The undisturbed portions of the Pat Hughes Creek drainage would consist of mainly conifer forest, which may provide foraging habitat for raptors and nesting habitat for other forest-dependent species. However, the undisturbed patch would be surrounded by WRSFs and may not be suitable for wildlife (negligible effect).

A total of 639.8 acres would be disturbed, with 69 percent of the area in mule deer winter range and 67 percent in elk winter range. The disturbance would cause the same overall effect compared to Alternative M1 (long-term and minor) as would Alternative M2.

4.7.2. Land Disposal Alternatives

4.7.2.1. Alternative L1 – No Action

There would be no changes to the current conditions for wildlife and special status terrestrial wildlife species for the selected or offered lands.

4.7.2.2. Alternative L2 – Land Exchange Proposal

There would be no effects to special status terrestrial wildlife species, or other wildlife, including big game for the selected land (apart from mining, Section 4.7.1). By better managing grazing in the riparian area along the Salmon River, the riparian area would support a greater density of riparian vegetation. This would be an improvement to the habitat for riparian and other migratory bird species, as well as big game (mule deer, elk, and bighorn sheep) at the ranch, especially for wildlife at BWR-1 (long-term, minor effects). The addition of 813 acres of PGH and PPH for sage-grouse within all of the ranch (Section 3.7.4; see BLM 2012b for definitions) would increase the amount of PGH and PPH (combined) in the BLM Challis Field Office by 0.1 percent (negligible effect).

Under Alternative L2-B the shrubland habitat that would develop at the ranch would be an increase in wildlife habitat in the BLM Challis Field Office area (BLM 1998) (long-term, minor effects). Not grazing the area would lead to full expression of native vegetation, yielding more cover for ground-nesting birds, pygmy rabbit, and possibly sage-grouse. Studies in the southwestern deserts show that not grazing (as under Alternative L2-B) compared to moderate grazing (as under Alternative L2), leads to lower diversity of wildlife such as rabbits, quail, dove, songbird, and raptors (Holechek 1991). Not grazing the area may lead to both positive and negative effects to greater sage-grouse brooding habitat (Beck and Mitchell 2000, Evans 1986). There would be no wolf predation on livestock (or controlled wolf kills in response), but wolf predation has not been an issue at the ranch to date (negligible effect). Big game would be able to utilize the natural forage which would provide more forage than irrigated fields used for grazing (long-term, minor effect). Wildlife would be displaced more often and further from the upper Lyon Creek Road due to vehicle noise (Section 4.10.2.2.) (long-term, minor effect).

There would be no effects to special status species, or other wildlife, including big game for the Garden Creek property, unless the property would have been developed under Alternative L1. In such case there would be a small amount (2 acres/~ 2 %) of additional wildlife habitat and less noise (negligible effects).

The selected land would contain more wildlife habitat (in acres) than the offered lands. However, the habitat at the selected land would generally be of common quality; typically, riparian areas, such as those found on the ranch, have higher diversity and value as wildlife habitat. The selected land would not contain any critical habitat areas or occupied habitat for any special status terrestrial wildlife species except possibly the flammulated owl in the S. Creek drainage (a flammulated owl was recorded north of the selected land). Nearly all of the selected land would be winter range for mule deer and elk (Table 4.7-3.), which would not be disturbed or modified (apart from mining, Section 4.7.1). Although pika were observed at the WRSFs, there would be no pika habitat outside of the MMPO area. Habitats at the selected land (Table 4.7-3.) may provide suitable habitat for other special status terrestrial wildlife species, including potential movement, foraging, or temporary roosting areas (negligible effects). There would be no meaningful changes in hunting pressure at the selected land; TCMC would allow non-motorized access to the only two areas of the land that occasionally have been used in the past by hunters, but would continue to not allow hunting by TCMC employees or the public on TCMC land.

The offered lands would contain much less habitat than the selected land (Table 4.7-3). However, in terms of habitat scarceness and suitability for special status terrestrial wildlife species, the offered lands would contain more suitable habitat, which would be more likely to be occupied in the future by special status terrestrial wildlife species than the habitats at the selected land. For example, the Broken Wing Ranch along the Salmon River is a scarce habitat. In addition, species such as sage-grouse, willow flycatcher, calliope hummingbird, or Brewer's sparrow may use the riparian or adjacent meadow/shrub habitat along Lyon Creek. Pygmy rabbits are likely to occur within toe slopes above the agricultural fields. Bald eagles roost along the river during winter. All of the ranch would be crucial winter range for mule deer and also would contain some winter range for elk and bighorn sheep. On the Garden Creek property, Townsend's big-eared bats were observed and would probably use the riparian or open areas for foraging. The habitat on portions of the ranch would be improved under BLM management, such as better managing grazing in riparian areas. These improvements would affect any big game animals, migratory birds, special status, or riparian species that use the local area on and around the ranch (long-term, minor effects).

There would be increased hunting pressure on the ranch (birds, waterfowl, and big game) and in the Lyon Creek drainage (long-term, minor effect to wildlife). Hunting has probably been limited on the Garden Creek property in the past, and there would be no meaningful increase in hunting on the property.

Table 4.7-3. Big game habitat types, Alternative L2.

Habitat	Selected Land	Offered Lands	
		Broken Wing Ranch	Garden Creek Property
Sagebrush	1,225	260	0
Riparian	71	32	1
Conifer Forest	3,356	0	79
Mule deer crucial winter range	0	803	0
Mule deer winter range	4,836	32	0
Elk winter range	5,073	81	0
Bighorn winter range	0	124	0

4.7.2.3. Alternative L3 – Land Sale

The effects to terrestrial wildlife and special status species at the selected land would be the same as under Alternative L2. There would not be any effects to wildlife (e.g., habitat improvement or increased hunting pressure) from BLM administration of the ranch (long-term, negligible to minor effects); the effects to the offered land would be the same as under Alternative L1. In addition, if the land was sold to a party other than TCMC, non-motorized access to the selected land might not be guaranteed (negligible effect due to the scarce public use of the selected land).

4.7.2.4. Alternative L4 – Reduced Area Land Exchange, Fee Simple

Less area (1,500 acres) of value to special status terrestrial wildlife species (especially the S. Creek drainage and densely forested areas south of Bruno Creek Road) would be acquired by TCMC compared to under Alternative L2. However, TCMC would not disturb or alter wildlife habitat on the selected land (apart from mining, Section 4.7.1.) (no difference in effect compared to Alternative L2).

Regarding the offered lands, the ranch contains potential habitat for special status terrestrial wildlife species. Specifically BWR-1, BWR-2, and BWR-3 along Lyon Creek contain meadow/shrub habitat adjacent to riparian areas for sensitive bird species, including sage-grouse. In addition, BWR-1 would be managed as big game winter range, and all of the subparcels contain crucial winter range for mule deer (Table 4.7-4). There would be no effect to wildlife if any of the subparcels were not acquired by the US because the value of the lands to wildlife would not change. If the Garden Creek property were eliminated from the land exchange, there would not be any meaningful changes to special status terrestrial wildlife species in the short term. If the property were developed over the long term there would be a reduction in the available habitat for these species.

Table 4.7-4. Big game habitat types, Alternative L4.

Habitat	Selected Land	Offered Lands							
		BWR-1	BWR-2	BWR-3	BWR-4	BWR-5	BWR-6	BWR-7	GC[1]
Sagebrush	928	108	6	3	5	49	57	32	0
Riparian	25	0	0	4	9	0	4	5	1
Conifer forest	2,217	0	0	0	0	0	0	0	79
Mule deer crucial winter range	0	151	110	39	143	98	209	54	0
Mule deer winter range	3,384	32	0	0	0	0	0	0	0
Elk winter range	3,530	81	0	0	0	0	0	0	0
Bighorn winter range	0	124	0	0	0	0	0	0	0

[1] Garden Creek property

4.7.2.5. Alternative L5 – Reduced Area Land Exchange, Easement

There would be no effects to wildlife or special status species on the selected land compared to Alternative L2 and Alternative L4. There would be no effects to wildlife or special status species if the ranch subparcels were not acquired by the US. As under Alternative L4, if the US were to not acquire the Garden Creek property there would be no effect to special status species.

4.8. Fish and Aquatic Resources

4.8.1. MMPO Alternatives

4.8.1.1. Alternative M1 – No Action

The 1980 EIS for the TCM (USFS 1980) describes the effects of the mine on aquatic habitat. In short, Buckskin Creek, No Name Creek, and Pat Hughes Creek did not have substantial fish populations, but might produce some organisms that could drift to Thompson Creek and be eaten by fish. There would be a distinct decrease in the aquatic resources of Buckskin Creek, No Name Creek, and Pat Hughes Creek, but no effects to fish populations in Thompson Creek. The TSF in the Bruno Creek drainage would cause longer periods of no/low streamflow in Bruno Creek downstream of the facility, which would decrease the amount of aquatic habitat and result in the loss of fish populations in Bruno Creek. The TSF would not generate substantial changes

in the water quality or hydrology of S. Creek or the Salmon River. Despite erosion and sediment controls, there would be some effects from sediment to spawning and rearing habitat in streams near the mine. Prior to the mine, all or nearly all of the streamflow in S. Creek downstream of Bruno Creek was diverted for agricultural uses. To mitigate the effects to Bruno Creek, TCMC committed to attempting to restore S. Creek as a viable anadromous fishery by acquiring and managing water rights in the creek to sustain a minimal year-round streamflow. Since then, mining has affected aquatic habitat, primarily in the Buckskin Creek, Pat Hughes Creek, and Bruno Creek drainages (Section 3.8). Effects to aquatic habitat and fish populations in Thompson Creek, S. Creek, and the Salmon River have been minimized through water management. However, decreased streamflow, changes in water quality, and minor effects to habitat due to adjacent roads have occurred.

Under Alternative M1 there would be no additional disturbance in the Thompson Creek and S. Creek drainages, and there would be no change to the length of intermittent and perennial streams affected. However, the effects to aquatic habitat and fisheries resources that may occur during mining from changes to current water quantity and quality (predicted changes and methodology are discussed in detail in Section 4.6.1.1.) would be the following:

- Negligible reductions (1 %) in Thompson Creek streamflow due to installation of cutoff walls and sedimentation pond linings in the Buckskin Creek and Pat Hughes Creek drainages to intercept shallow groundwater seepage flows that bypass the NPDES outfalls in these drainages and reach Thompson Creek.
- Decreased concentrations of many constituents in Thompson Creek (other than those listed below) for both the best and upper estimates due to installation of the cutoff walls.
- Increased concentrations of some constituents in Thompson Creek over time (even with the cutoff walls) due to degradation of the residual seepage. The concentrations of copper and lead would be predicted to increase above the current concentrations for the best estimate for both the low flow and 7Q10 flow. The concentrations of aluminum, cobalt, copper, lead, manganese, uranium, and zinc would be predicted to increase above the current concentrations for the upper estimate for low flow. The concentrations of aluminum, cadmium, cobalt, copper, lead, manganese, uranium, and zinc would be predicted to increase above the current concentrations for the upper estimate for the 7Q10 flow. The concentrations of iron would be similar or slightly greater than the current concentration for all scenarios. The concentrations of all constituents in Thompson Creek would meet all WQSs;
- Slightly increased flow in S. Creek (< 0.01 cfs) due to increased seepage from the TSF to Redbird Creek; and
- Water quality in S. Creek would be predicted to remain the same as the current condition, i.e., seepage from the TSF to Redbird Creek would not be expected to affect the water quality of S. Creek.

The effects to aquatic habitat and fisheries resources from changes to current water quantity and quality that may occur during early reclamation (Years 1 to 5 after mining and milling is completed) would be the following (Section 4.6.1.1.):

- Increased flow to Bruno Creek and S. Creek because upper Bruno Creek would no longer be diverted to the mill;
- Decreased flow (< 0.01 cfs) to S. Creek from Redbird Creek due to decreased seepage from the TSF; and
- Effects to S. Creek water quality during Years 1 to 5 due to ARD from the TSF embankment (not the impoundment) and continued seepage to Redbird Creek. There would be predicted increases in the concentrations of sulfate, arsenic, cobalt, iron, manganese, and nickel for the best estimate during low flow. For the best estimate for the 7Q10 flow there would also be predicted increases in the concentrations of these same constituents plus uranium and zinc. There would be predicted increases in the concentrations of sulfate, arsenic, cobalt, copper, iron, manganese, nickel, uranium, and zinc for the upper estimate for the low flow and 7Q10 flow. The concentrations of all constituents in S. Creek would meet all WQSs.

The effects to aquatic habitat and fisheries resources from changes to current water quantity and quality that may occur during late reclamation (Years 6-plus after mining and milling is completed) would be the following (Section 4.6.1.1.):

- Possible effects to the S. Creek water quality due to the ARD from TSF embankment. There would be predicted increases in the concentrations of sulfate, aluminum, arsenic, cadmium, cobalt, copper, iron, lead, manganese, nickel, uranium, and zinc for both best and upper estimates for the low flow and 7Q10 flow. With the exception of the concentration of cadmium for the 7Q10 flow/upper estimate, the concentrations of these constituents would meet all WQSs;
- Increased flow in the Salmon River as water would no longer be diverted and pumped to the mill and water would be discharged from NPDES Outfall 005; and
- Effects to the Salmon River water quality due to discharge from NPDES Outfall 005, in addition to water from Thompson Creek and S. Creek. There would be predicted increases in the concentrations of sulfate, aluminum, cadmium, cobalt, manganese, selenium, and uranium for both the best and upper estimates for low flow. There would be predicted increases in the concentrations of these constituents, and the concentrations of molybdenum, nickel, and zinc for the 7Q10 flow/best estimate. For the 7Q10 flow/upper estimate there would be a predicted increase in the concentrations of all of these constituents (sulfate, aluminum, cadmium, cobalt, manganese, molybdenum, nickel, selenium, uranium, and zinc) and the concentration of copper. The concentrations of all constituents in the Salmon River would meet all WQSs; and

- Potential effects to water quality due to unanticipated problems in the long-term water management system.

Fish in the Salmon River use the mouths of tributary streams as refuge from warm water temperatures in the Salmon River. Sockeye salmon are considered to exhibit this behavior as well, particularly during summer months. Under upper estimates for water quality in both Thompson Creek and S. Creek, concentrations of copper and cadmium, respectively, may be elevated, particularly during the 7Q10 flow. During periods of low flow, such as the 7Q10 flow, water temperatures in the Salmon River would likely be elevated, and fish would seek thermal refuge. As a result, adult sockeye salmon moving up the Salmon River could be seeking thermal refuge at the mouth of these streams at the same time that concentrations of these contaminants may be elevated. Because some mixing would occur as the tributaries meet the Salmon River, concentrations would be lower than predicted in the tributaries and would likely not exceed water quality criteria. However, in the case of copper, concentrations may still be high enough to result in effects such as sensory impairment. It is highly unlikely that water quality would be a concern in both streams simultaneously. As a result, in a situation with elevated copper in Thompson Creek, S. Creek could also be used as thermal refuge (and vice versa in the case of cadmium).

Aquatic Habitat

As described above, effects would be as a result of changes to water quantity and quality. As there would be only negligible changes in flow rates for Thompson Creek and S. Creek (see below), and there would not be changes to temperature or to indicators not specific to water quantity and quality. Therefore, only the NMFS and USFWS indicators specific to water quantity (peak/base flows) and quality (sediment/turbidity, chemical contamination and nutrients) that could be affected by these changes are discussed in this section. In addition, as there would be no new disturbance under Alternative M1, the effects to disturbance history and riparian reserves are not discussed in this section.

Thompson Creek

Sediment and Turbidity

The current levels of sediment and turbidity (well quantified from more than 30 years of monitoring) would continue during mining and reclamation. Extreme flood events might lead to increased sediment and turbidity from the mine (e.g., those greater than the event for which operational and closure facilities would be designed), but would likely not be excessive as most mine disturbance capable of producing large amounts of sediment (i.e., roads, waste rock facilities, and other similar disturbance) are located away from Thompson Creek. In addition, given that most of the disturbance is located in the Buckskin and Pat Hughes drainages, any sediment released from disturbance in the upper portions of these drainages would be conveyed along Buckskin Creek or Pat Hughes Creek, which have sedimentation ponds in place. The sediment ponds are approximately 0.3 and 0.4 miles from Thompson Creek, respectively. In addition, the amounts of sediment and turbidity in Thompson Creek from the mine during extreme flood events would be small compared to the amounts from areas unaffected by the

mine, especially considering the distance of the majority of the mine disturbance from Thompson Creek.

Chemical Contamination and Nutrients

The construction of cutoff walls would reduce the amount of seepage reaching Thompson Creek from the WRSFs. This would reduce the concentration of most constituents in Thompson Creek; however, there would be an increase in the concentrations of the constituents described in the beginning of this section under both best and upper estimates due to degradation of residual seepage. However, the WQSs would continue to be met under both best and upper estimates (long-term, minor effect). Unanticipated problems with the water management system, particularly the collection and transport of mine-affected water from Buckskin Creek and Pat Hughes Creek to the treatment system could lead to exceedances of WQSs (with exceedance of the selenium standard being the most likely) and potential effects to aquatic life in Thompson Creek. In most cases, this would be a temporary and minor effect as exceedances of the selenium standard occurred between 2000 and 2004 without obvious effects to aquatic life (Section 3.6.1.2).

Peak/Base Flows

The construction of cutoff walls and pond linings would reduce streamflow in Thompson Creek by approximately 1 percent. Under average baseflow conditions (4.2 cfs) the reduction would be 0.04 cfs. Under the less frequent 7Q10 flow (2.0 cfs) the reduction would be 0.02 cfs (negligible effect). Other current effects such as decreased peak flows due to high infiltration rates in the WRSFs and decreased base flows due to water management (i.e., diversion of flows in Buckskin Creek and Pat Hughes Creek) would continue. The current baseflow is a limiting factor to fish populations in Thompson Creek (IDFG 2005a).

S. Creek

Sediment and Turbidity

There would be the same effects to S. Creek as described above for Thompson Creek (negligible).

Chemical Contamination and Nutrients

During mining the S. Creek water quality would be the same as at present (negligible effects). As described in the beginning of Section 4.8.1.1., during Years 1 to 5 there would be increases in the concentrations of several constituents during low flow and the 7Q10 flow under the best and upper estimates. However, even for the upper estimates (the most conservative calculations) all WQSs would be met (short-term, minor effects with seepage to Redbird Creek decreasing over time). During late reclamation (Years 6-plus) there would be increases in the concentrations of several constituents but all WQSs would be met (long-term, minor effect), except for the upper estimates during the 7Q10 flow for which the concentration of cadmium would be greater than the CCC WQS (0.74 µg/L, assuming a hardness of 157 mg/L). Reduction in habitat suitability due to exceedance of WQS for aquatic life during the 7Q10 flow in S. Creek would be a moderate effect. The probability of substantial seepage from the TSF not being captured by the

SRD is low and any WQS exceedances would be temporary (i.e., limited to the low flow period), but the potential for these exceedance "events" would continue long-term.

The effects to Bruno Creek water quality were not evaluated for Years 6-plus because of the current significant effects to aquatic habitat from the mine. However, any seepage not captured by the SRD could reach Bruno Creek. The probability and duration of any seepage reaching Bruno Creek would be the same as for S. Creek. Although re-routing Bruno Creek around the TSF would restore a more natural flow regime to lower Bruno Creek and provide additional water, because Bruno Creek contains less flow to dilute any chemical contamination, the magnitude of effects would be greater than in S. Creek.

Peak/Base Flows

The increase S. Creek streamflow due to seepage from the TSF to Redbird Creek might be approximately 35 gpm (less than 0.08 cfs) during mining and year 1-5 following mining, which would gradually decrease to no flow contribution from Redbird Creek during Years 6-plus following mining when the TSF would be mostly dewatered (negligible effect). The re-routing of Bruno Creek over the top of the TSF after reclamation would increase the amount of water to lower Bruno Creek and S. Creek during peak flow/base flow as the water would no longer be diverted for use in the mill. Although the amount of this increase would be relatively small for S. Creek (negligible effect), there would be more natural flow in lower Bruno Creek, which would benefit fish populations (long-term, moderate effect).

Salmon River

Chemical Contamination and Nutrients

During mining the water quality in the Salmon River would be the same as present. Approximately 30 years after mining water would begin to be removed from the pit lake, treated, and discharged to the Salmon River through Outfall 005 (Section 4.6.1.1). This would lead to higher concentrations of several constituents in the Salmon River under both best and upper estimates (as detailed in the beginning of this section), but all WQSs would be met (long-term, minor effect). Changes in the treatment process (or water discharge rates from the pit lake) may be required to maintain water quality as modeled. TCMC has committed to implement and maintain, in perpetuity, whatever types of treatments are needed to maintain ambient water quality in the Salmon River.

Peak/Base Flows

At the end of mining the withdrawal of water from the Salmon River for the mill would cease and there would be an increase (4.5 cfs) to the flow of the river. Approximately 30 years after mining when treated water would be discharged to Outfall 005, there would be an additional increase (2.03 cfs) to the flow of the river. Compared to the average annual low flow (winter months) of 388 cfs, these increases (1.2 % and 0.5 %) would be negligible effects even during low flow. The effects would be long term as discharge from the pit lake would continue in perpetuity.

Fish Populations

Thompson Creek

The minimal decrease (~ 1 %) in Thompson Creek streamflow and the small changes to water quality under both the best and upper estimates would not be expected to affect either long-term fish population numbers or distribution of bull trout, Chinook salmon, steelhead/rainbow trout, cutthroat trout, or sculpin. Although concentrations of all metals are expected to meet IDEQ criteria for aquatic life, there is the possibility that some metals could bioaccumulate to concentrations sufficient to cause effects. Based on current and predicted water quality in Thompson Creek, only selenium would be of potential concern for bioaccumulation. Excessive selenium bioaccumulation in fish can result in larval developmental abnormalities and mortality (Holm et al. 2005).

Bioaccumulation of selenium occurs in Thompson Creek (Section 3.8.), but ongoing biological monitoring of Thompson Creek shows macroinvertebrate, sculpin, and trout populations have apparently not declined due to the mine operations (Chadwick 2005, GEI 2011). As the concentrations of selenium in Thompson Creek would remain lower than the concentrations in Thompson Creek during the selenium bioaccumulation studies, any effects of an increased concentration of selenium would be negligible.

Any problems in the water management system would lead to temporary increases in sediment and/or chemical constituents downstream of the mine facilities. A pulse of sediment (from a flood event greater than design capacity of the water management facilities) would lead to a decline in habitat quality and possibly spawning habitat. However, the effects of sediment would be mitigated by Thompson Creek also being at flood state with elevated sediment loads from natural conditions outside the mine water management area (short-term, negligible to minor effect). Accidental releases of contaminated water to Thompson Creek from Buckskin Creek or Pat Hughes Creek would not affect fish populations when streamflow in Thompson Creek is above approximately 7 cfs, as there is sufficient flow to dilute inflows from these creeks. At low flows (i.e., less than 7 cfs in Thompson Creek) upsets in the water management system, are much less likely to occur (relative to high flow events greater than design capacity), but would lead to temporary increases in selenium. Temporary increases occurred prior to water management changes (2000 to 2004) with negligible effect to fish populations and effects of an upset in the water management system would be similar (negligible effect).

S. Creek

The minimal increases in streamflow and in concentration of several constituents in S. Creek during mining and during early and late reclamation would not meaningfully affect fish populations in S. Creek under best estimates, as concentrations would meet WQSs (negligible effects). Under the upper estimate during Years 6-plus, there would be the potential for cadmium concentrations to exceed the CCC for aquatic life (1.11 µg/L compared to the CCC of 0.74 µg/L during 4 days). Aquatic organisms should not be affected unacceptably if the four-day average concentration of a constituent does not exceed the CCC more than once every three years on average (EPA 2011a). In the case of cadmium predictions for S. Creek, the frequency of exceedance is predicted to be less than every three years (10 years, by definition under the 7Q10 flow). However, it is possible for the CCC criteria to be exceeded for longer than 4 days

(7 days under the 7Q10 flow) and although the probability of an exceedance is low (only under the most conservative upper estimate during extremely low flow) the potential for effects could not be eliminated.

Cadmium is most toxic to salmonids during the juvenile and larval life stages. In addition, steelhead may be more sensitive to cadmium than Chinook salmon. The 96 hour LC50 (the concentration that is lethal to 50 % of the organisms) for steelhead was as low as 1.0 µg/L cadmium for steelhead parr and 1.8 µg/L cadmium for Chinook salmon swim-ups (Chapman 1978). Mebane et al. (2012) studied sensitivity to cadmium for cutthroat trout, rainbow trout, and shorthead sculpin and found 96 hour EC50s (the concentrations causing a specified effect on 50 % of the organisms, in this case loss of equilibrium, immobilization, or death) ranging from 0.3 to 1.5 µg/L. However, in both these studies the water hardness was much lower (< 70 mg/L) than in S. Creek (157 mg/L), and cadmium toxicity decreases substantially with increases in hardness. For example, the Idaho WQS for the CCC for cadmium (0.6 µg/L for a hardness of 100 mg/L) would be 0.5 µg/L for a hardness of 70 mg/L and 0.8 µg/L for a hardness of 157 mg/L.[4] Mixtures of metals also typically have interactive effects leading to toxicity at lower or higher concentrations than from a single metal alone (Finlayson and Verrue 1982). Cadmium does not readily bioaccumulate in fish (EPA 2001).

The possible effects to fish in S. Creek from the predicted concentration of cadmium during the 7Q10 flow would include low levels of the typical effects of cadmium to fish: reduced survival of larval fish; avoidance behavior that may limit feeding, migration, or predator avoidance. These could lead to a short-term decrease in juvenile recruitment for the year of an exceedance; a decline in fish population size; or reduced health of adult fish. With the temporary nature of cadmium effects, declines in fish population size would be small, and populations would rebound in subsequent years. Given the low numbers of bull trout, Chinook salmon, and spawning steelhead in S. Creek, the effects of elevated concentrations of cadmium could be more pronounced than for the more common rainbow trout and cutthroat trout, in that it would take longer for populations to recover from a particular event. As a result, effects would be moderate (i.e., would not affect persistence in S. Creek, but would be sufficient to be seen on a population scale due to reduced recruitment and smaller population numbers). Although individual "events" would be short-term, the potential for them to occur is long-term.

As described above (S. Creek, chemical contamination and nutrients), the effects of increased concentrations of constituents might be greater to cutthroat trout in lower Bruno Creek where concentrations of constituents could be higher than in S. Creek. In such case, the effects to fish populations (cutthroat trout) in Bruno Creek would probably be either the same as for S. Creek (long-term, moderate effect) or greater (long-term, major effect). Probability and frequency of effects would be the same as described for S. Creek. A major effect would be the same as was described for Bruno Creek (e.g., the substantial destruction of the aquatic habitat and fish populations) for the 1980 EIS (USFS 1980). Also, water management would be focused on reducing the potential for seepage to Bruno Creek and S. Creek from the TSF (currently all seepage is captured at the SRD and pumped back to the mill, which prevents it from reaching Bruno Creek and S. Creek) which would reduce the potential for the effects described above.

[4] $1.0 \times e^{[0.6247\ln(\text{hardness}) - 3.344]} \times 0.909$ (IDAPA 58.01.02.210.02)

Salmon River

The water quality after reclamation would have increased concentrations of the constituents previously described, but would meet all WQSs for both best and upper estimates during both low flow and the 7Q10 flow (negligible effect).

Macroinvertebrate Organisms

Thompson Creek

An increase in the concentrations of several constituents could cause reduced overall taxa richness and fewer EPT taxa, as described in Section 3.8.1.5. However, all WQSs would be met under the best and upper estimates (long-term, minor effect). Selenium has the potential to bioaccumulate in macroinvertebrate organisms, but monitoring has shown no clear trends or declines in macroinvertebrate populations due to mine operations (Chadwick 2005, GEI 2011), including selenium bioaccumulation (negligible effect). Effects from upsets in the mine water management system could include both sediment and chemical contamination. A pulse of sediment may lead to a decline in habitat quality for macroinvertebrates (due to the filling of interstitial spaces), but would not affect long-term population numbers or community compositions, as the stream would be expected to return to baseline equilibrium conditions as the sediment is transported out of the system (temporary to short-term, negligible to minor effect). Effects of accidental chemical contamination on macroinvertebrate organisms would be the same as described for fish populations (negligible effect).

S. Creek

An increase in the concentrations of several constituents could cause reduced overall taxa richness and fewer EPT taxa, as described in Section 3.8.1.5. However, all WQSs would be met during mining, under the best and upper estimates during Years 1 to 5 (short-term, minor effect), and under the best estimate during Years 6-plus (long-term, minor effect). For the upper estimate during Years 6-plus, the potential for concentrations of cadmium greater than the CCC for aquatic life would include greater decreases in overall taxa richness and taxa richness of metals-sensitive orders than described for the other scenarios (changes in community composition on the population scale). Any such effects would cease following extreme low flow periods (predicted to occur only under infrequent 7Q10 flow and only under the most conservative estimates), but the potential to occur would continue long-term (long-term, moderate effect).

Salmon River

There would be at most slight (but measureable) decreases in taxa richness (no changes in the community composition or overall abundance) for metal-sensitive orders (long-term, minor effect).

4.8.1.2. Alternative M2 – MMPO as Submitted by TCMC

There would be increased disturbance in both the Thompson Creek and S. Creek watersheds due to expansion of the WRSFs and the TSF. This would include Pat Hughes Creek (and tributary) channel (3,749 feet), Bruno Creek (and tributaries) channel (1,204 feet), and Mill Creek channel (4,397 feet) (as part of reclamation) (Section 4.9.1). The additional disturbance in the Buckskin

Creek drainage would be in the upper watershed and would not disturb any additional reaches of the stream. Because these creeks have already been heavily modified by the mine, the majority of the potential effects to aquatic habitat and fisheries resources would be due to changes in water quantity and quality. During mining the changes that would affect aquatic resources would be the following (Section 4.6.1.2.):

- Negligible reductions in flow in Thompson Creek (2 % relative to current conditions, an additional 1 % relative to Alternative M1,) due to increase disturbance in the drainage and the additional cutoff walls in the Pat Hughes Creek drainage;
- Decreased concentrations of many constituents (relative to current conditions) in Thompson Creek (other than described below) for both the best and upper estimates due to installation of the cutoff walls;
- Additional degradation of water quality in Thompson Creek due to the expansion of the WRSFs. The concentrations of aluminum, copper, manganese, and molybdenum would be predicted to increase for the best estimate for low flow and the 7Q10 flow. The concentrations of aluminum, cadmium, cobalt, copper, lead, manganese, molybdenum, nickel, selenium, uranium, and zinc would be predicted to increase for the upper estimate for both low flow and the 7Q10 flow. With the exception of copper for the upper estimate under the 7Q10 flow, the concentrations of all of these constituents would meet all WQSs;
- Additional, but small increases in the flow in S. Creek (~ 0.03 cfs relative to current conditions and 0.01 cfs relative to Alternative M1) due to increased seepage to Redbird Creek; and
- Additional, but small increases in the flow in the Salmon River during mining (~ 0.4 cfs).

During Years 1 to 5 and Years 6-plus after mining and milling is completed changes to water quantity and quality would be the same as for Alternative M1, with the exception of the following (Section 4.6.1.2.):

- The same constituents predicted to increase in S. Creek for Alternative M1 during Years 1 to 5 would increase, but the predicted concentrations would be slightly higher.
- There would be an increase in the concentration of manganese in S. Creek (for which there is no WQS) during Years 1 to 5 for both the best and upper estimates for both low flow and the 7Q10 flow (no increase during Years 6-plus).
- There would be negligible increases in the flow in the Salmon River following reclamation (6.6 cfs compared to 6.5 cfs under Alternative M1); and
- The concentrations of the constituents in the Salmon River would increase slightly relative to Alternative M1 but would meet WQSs.

The increased amount of waste rock in the Buckskin Creek and Pat Hughes Creek drainages would contribute dissolved solutes to mine-affected water and potential effects to Thompson Creek. Additional cutoff walls included under Alternative M2 would reduce some of these effects and predicted concentration of some constituents (arsenic, cadmium, iron, lead, and nickel) would be the same under Alternative M2 as Alternative M1; however, others would increase. Under all scenarios, predicted concentrations of constituents in Thompson Creek would meet IDEQ WQSs, with the exception of copper under the upper estimate for the 7Q10 flow. The predicted upper estimate for copper during the 7Q10 flow would be 8.24 µg/L, which would exceed the CCC of 6.0 µg/L (assuming a hardness of 47 mg/L). Changes to water quality in S. Creek and the Salmon River would be similar to those described under Alternative M1 for all scenarios, with only slight increases in concentrations of the same metals described for Alternative M1 during Years 1 to 5 for S. Creek and the Salmon River. The predicted concentrations under all estimates for Years 6-plus would be the same as described for Alternative M1. Monitoring and adaptive management related to water quality is summarized in Section 2.1.6. and Section 4.21.

Aquatic Habitat

Effects to aquatic habitat are similar to those described under Alternative M1 for sediment and turbidity (with the exception of the additional cutoff wall in Pat Hughes WRSF, the overall water management during operation and closure is unchanged between these two alternatives). As a result, the effects for sediment and turbidity would be the same as for Alternative M1. Changes to disturbance history and riparian reserves would occur in the Thompson and S. Creek watersheds, and are discussed below along with chemical contamination and nutrients, and peak/base flows.

Thompson Creek

Chemical Contamination and Nutrients

There could be an increase in the concentrations of several constituents from increased constituent loads in seepage passing around the additional cutoff walls due to increased areas taken up by the WRSFs and continued/predicted degradation WRSF seepage. The concentrations of copper, lead, and manganese would increase under the best estimate for both the annual low flow and the 7Q10 flow; and aluminum, cadmium, cobalt, copper, iron, lead, manganese, uranium, and zinc under the upper estimate for both the annual low flow and the 7Q10 flow. Under the best estimate and upper estimate/low flow scenarios, all WQSs would be met (long-term, minor effect). Under the most conservative 7Q10 flow/upper estimate scenario, the concentration of copper (8.24 µg/L) could exceed the CCC WQS (6.0 µg/L) (long-term, moderate effect). Although the individual exceedances would be temporary (i.e., limited to the 7Q10 flow), the potential for these exceedance "events" would continue long-term.

Peak/Base Flows

There would be a reduction in the flow of Thompson Creek of 0.01 cfs (1 %) during the 7Q10 flow in addition to a reduction of 0.01 cfs under Alternative M1 (negligible effect).

Disturbance History

There would be approximately 2,100 acres of disturbance in the Thompson Creek watershed compared to 1,824 acres for Alternative M1 (long-term, minor effect to aquatic habitat).

Riparian Reserves

There would be no disturbance along Thompson Creek, but the expansion of the Pat Hughes WRSF would permanently remove 3,749 feet of the Pat Hughes Creek channel/tributary and their (discontinuous) riparian vegetation. However, Pat Hughes Creek is part of the water management system and is no longer a natural waterway and there would be little change relative to functional aquatic habitat (negligible effect).

S. Creek

Chemical Contamination and Nutrients

During mining the loads of sulfate and chloride to Redbird Creek would increase, but given the small proportion of the flow of S. Creek from Redbird Creek, the effects to water quality and aquatic habitat would be negligible. During Years 1 to 5 after closure the seepage would continue in the short term, and water quality would essentially be the same for both the best and upper estimates as for Years 1 to 5 for Alternative M1 (short-term, minor effect). During Years 6-plus, the concentrations of all constituents would be similar to Alternative M1, with slightly higher concentrations for some constituents. With the exception of cadmium under the most conservative 7Q10 flow/upper estimate, all concentrations would meet WQS (long-term, minor effect). The effects of concentrations of cadmium above the CCC WQS would be the same as for Alternative M1 (infrequent moderate effect with potential to occur long-term).

Peak/Base Flows

There would be small (0.02 cfs) increases in flow to S. Creek due to seepage to Redbird Creek in addition to the 0.01 cfs for Alternative M1 during mining and Years 1 to 5 after mining (negligible effect). The increased flow would gradually decrease to zero during Years 6-plus when the TSF would be mostly dewatered.

Disturbance History

There would be 1,163 acres of disturbance in the S. Creek watershed compared to 992 acres for Alternative M1 (long-term, minor effect).

Riparian Reserves

There would be no disturbance along S. Creek. However, the TSF would permanently remove (discontinuous) riparian vegetation along 1,204 feet of Bruno Creek and its tributaries, and 4,379 feet of Mill Creek (tributary to Bruno Creek). The affected reaches of these S. Creek tributaries are currently fragmented by the TSF and SRD. As a result, the decrease in riparian habitat would be isolated from S. Creek and lower Bruno Creek. The removal of 1,204 feet of stream channel in upper Bruno Creek would have little affect because the riparian vegetation would be so sparse (negligible effects).

Salmon River

Chemical Contamination and Nutrients

During mining water quality would be the same (negligible effects). After reclamation and the start of pit lake discharge through NPDES Outfall 005, the concentration of several constituents would be higher under both the best and upper estimates. The concentrations of constituents predicted to increase would be the same as described for Alternative M1 (with most predicted concentrations the same as under Alternative M1, some slightly higher). The concentrations would meet all WQSs under both best and upper estimates (long-term, minor effects). As described for Alternative M1, meeting water quality criteria would require that all water discharged to the Salmon River be treated prior to discharge, and changes in the treatment process (or water discharge rates) may be required to maintain water quality. TCMC has committed to implement and maintain, in perpetuity, whatever types of treatments are needed to maintain ambient water quality in the Salmon River.

Peak/Base Flows

During mining there would be a small increase (0.4 cfs, 0.1 % of the average annual low flow) in the flow of the Salmon River as the deeper open pit would intercept more groundwater that would be used instead of withdrawing water from the river (it would be more economical to pump from the pit than the river) (negligible effect). After reclamation there would be 2.11 cfs of treated water discharged to the Salmon River, compared to 2.03 cfs under Alternative M1. Combined with the 4.5 cfs that would no longer be withdrawn at the end of mining, the increase in the flow of the Salmon River would be 6.61 cfs, or 6.4 percent of the 7Q10 flow of 103 cfs (long-term, minor effect), and 1.7 percent of the average annual flow (negligible effect).

Fish Populations

Thompson Creek

There would be very minimal (1 %) additional effects to streamflow (relative to Alternative M1) and although constituents would increase relative to baseline condition (with slight increases for some relative to Alternative M1), the concentrations under the best estimate and the upper estimate under all but extreme low flows would meet WQSs (negligible effect). The concentrations of copper under the most conservative upper estimate (8.24 µg/L) are predicted to exceed the CCC WQS (6.0 µg/L assuming a hardness of 47 mg/L, see Section 4.6.1.2.) during the 7Q10 flow. As explained for cadmium in S. Creek (Section 4.8.1.1.), fish may be affected under a scenario where the CCC criteria is exceeded during the 7Q10 flow because it is possible for the CCC to be exceeded for longer than 4 days (i.e., 7 days).

Copper can have a variety of effects on salmonids including mortality, reduced olfactory function, interference with migration, and an impaired immune response (Chapman 1978, Baldwin et al. 2003, Woody 2007). Similar to cadmium, copper is most toxic to salmonids during the juvenile and larval life stages (Chapman 1978). Chapman (1978) also found that steelhead are more sensitive to copper than Chinook salmon. The 96 hour LC50 (the concentration lethal to 50 % of the organism) for steelhead was as low as 17 µg/L for steelhead parr (age 1-3) and 19 µg/L for Chinook salmon swim-ups (larval fish just emerging from spawning gravels). Copper toxicity decreases with an increase in hardness. The hardness

identified in the studies of Chapman (1978) (22 to 67 mg/L) compared to the hardness (47 mg/L) associated within Thompson Creek indicates the toxicity results would be comparable to Thompson Creek.

Copper may affect fish at concentrations lower than that which would cause mortality and lower than some state WQSs (Woody 2007). Several studies (e.g., Baldwin et al. 2003, 2011) have shown that short-term, small increases (3 µg/L) in the concentration of copper can impair olfactory function in coho salmon and steelhead. These effects can be at least partially reversible, although the effects from exposures more than 4 hours may take weeks to reverse (Baldwin et al. 2003). Loss of olfactory function can subsequently influence feeding, predator avoidance, and migration (Woody 2007). Furthermore, exposure to sub-lethal concentrations of copper can increase fish stress, which subsequently increases both infection and mortality rates (Woody 2007).

The upper estimates for copper during the 7Q10 flow would not result in direct mortality, but may have lower level effects on behavior and disease susceptibility that might indirectly reduce survival, i.e., short-term declines in fish population size for bull trout, Chinook salmon, steelhead/rainbow trout, cutthroat trout, and sculpin. Regardless, there would not be a reduction in fish population viability in Thompson Creek as reproduction and recruitment in subsequent years would be unaffected. Although the probability is low (based on conservative upper estimates), effects could be of a magnitude sufficient to be seen on a population scale (behavioral effects and disease susceptibility that may reduce survival). As a result, the effects would be moderate. Although individual "events" would be short-term, the potential for them to occur is long-term. The slightly increased concentrations of selenium (relative to Alternative M1) would be lower than the concentrations measured from 1999 to 2010 (negligible effects from bioaccumulation).

S. Creek

The effects would be essentially the same as for Alternative M1, with only negligible decreases in water quantity and minor changes to water quality during mining and Years 1 to 5 due to increased seepage to Redbird Creek (short-term, negligible effects under both best and upper estimates during Years 1 to 5; long-term, negligible effects for best estimate for Years 6-plus). Under upper estimates, there would be the potential for cadmium exceedances during the 7Q10 flow (moderate effects). The duration of moderate effects would be short-term, but with the potential to occur over the long term.

Salmon River

Effects to fish in the Salmon River would be negligible as described for Alternative M1.

Macroinvertebrate Organisms

Thompson Creek

Under best estimates, there would be the same effects to macroinvertebrate organisms in Thompson Creek as for Alternative M1, which may include reduced overall richness and fewer metal intolerant taxa such as the EPT taxa (long-term, minor effect). Under upper estimates, effects would include greater decreases in overall taxa richness and taxa richness of metals-

sensitive orders if the CCC for copper were exceeded. As these effects would be seen on a population scale, with changes in community composition, the effects would be moderate. It is expected that community composition would recover following extreme low flow periods (exceedances are only predicted under the 7Q10 flow) and moderate level effects would be short-term. However, the potential for exceedances to occur would continue long-term.

S. Creek

These effects would be the same as previously discussed (Alternative M1) for the best and upper estimates for Years 1 to 5 (short-term, minor effects) and best estimates for Years 6-plus (long-term, minor effects). The effects under the most conservative upper estimate for the potential cadmium exceedance in S. Creek would also be the same as described for Alternative M1(moderate effect that would be short-term in duration with the potential to occur long-term).

Salmon River

The effects to macroinvertebrate organisms in the Salmon River would be essentially the same as for Alternative M1 (long-term, minor effect).

4.8.1.3. Alternative M3 – No Name Waste Rock Storage Facility

Under Alternative M3 the majority of water management would continue unchanged from Alternative M2, and the effects to S. Creek and the Salmon River would be similar to the effects for Alternative M2 (Section 4.8.1.2). Any differences between the effects for Alternative M3 and the effects for Alternative M2 would be in the Thompson Creek watershed. The No Name Creek is intermittent and does not contain fish. The No Name WRSF would disturb up to 5,606 feet of intermittent stream channel (74 % of the surveyed channel length), in addition to the new disturbance of 3,749 feet of the Pat Hughes Creek channel, 1,204 feet of the Bruno Creek channel, and 4,397 feet of the Mill Creek channel. Other than this disturbance to tributaries, effects to Thompson Creek fish and aquatic resources would be through effects to water quantity and quality as described for other alternatives.

The effects to Thompson Creek compared to the effects for Alternative M2 would be reduced flow (run-off) from No Name Creek (as mine-affected water would be collected and used for mining, and after mining the water would be treated and discharged to the Salmon River) and potential seepage from the No Name WRSF that could degrade shallow groundwater discharging to Thompson Creek (Section 4.6.1.3).

Calculations of water quality were not made for Alternative M3 because of the lack of data for the No Name Creek drainage, and because the potential effects to Thompson Creek from the WRSFs in the adjacent Buckskin Creek and Pat Hughes Creek drainages are well defined for Alternative M1 and Alternative M2 and may be generally applied to the No Name Creek drainage for a conservative analysis. It is unknown to what extent a cutoff wall or other mechanism would capture seepage from a WRSF in the No Name Creek drainage and prevent the seepage from discharging to Thompson Creek. Therefore, construction of a new WRSF in the No Name Creek drainage would probably result in similar effects to groundwater quality as have already occurred at the Buckskin and Pat Hughes WRSFs. It may be possible for an underdrain system to be installed that would capture most if not all the seepage and limit the

contamination of shallow groundwater that reaches Thompson Creek. However, any groundwater effects from the No Name WRSF would be additive to that which would occur under Alternative M1.

Aquatic Habitat

The effects to aquatic habitat for S. Creek and the Salmon River would be the same as described for Alternative M2 (Section 4.8.1.2). For Thompson Creek, the effects to sediment, turbidity, and water management during operations and closure would be similar between these two alternatives. The changes to disturbance history and riparian reserves are discussed below along with chemical contaminants and nutrients and peak/base flows.

Thompson Creek

Chemical Contamination and Nutrients

The concentrations of various constituents reaching Thompson Creek from shallow groundwater would at a minimum be the same as under Alternative M2, if not greater, and there would be very similar probabilities of a similar exceedance of the CCC for copper under upper estimates during the 7Q10 flow (long-term, moderate effect). Constituents other than copper would remain below WQSs under scenarios similar to the best estimates used for Alternative M2 (long-term, minor effect).

Peak/Base Flows

Using drainage area as an analog to flow production, the No Name Creek WRSF would cause a slightly greater percentage of decreased surface water flow to Thompson Creek than under Alternative M2 (Section 4.6.1.3.) (negligible effect).

Disturbance History

There would be 2,244 acres of disturbance in the Thompson Creek watershed compared to 1,824 acres for Alternative M1 and 2,100 acres for Alternative M2. Similar management to that used in the Buckskin and Pat Hughes drainages (sedimentation ponds, pumping of contaminated water to the mill, etc.) would reduce the effects of disturbance (long-term, minor effect).

Riparian Reserves

As for Alternative M3, there would be no disturbance along Thompson Creek, and the effects to Thompson Creek from sediment and turbidity would be essentially the same as for Alternative M2. However, the Pat Hughes WRSF would still need to be enlarged which would permanently remove 3,749 feet of stream channel and (discontinuous) riparian vegetation in the Pat Hughes Creek drainage. The stream is now part of the water management system and would no longer function as a natural stream with an altered channel, sedimentation ponds, and no discharge during many years (same effect as for Alternative M2). As a result, there would be little change in baseline condition relative to current occupied aquatic habitat in Thompson Creek (negligible effect).

Fish Populations

The minimum effects to fish populations would be essentially the same as for Alternative M2, with the possibility for greater effects depending on changes in water quality from No Name Creek and the accompanying water management strategies.

Macroinvertebrate Organisms

The minimum effects to macroinvertebrate organisms would be essentially the same as for Alternative M2, with the possibility for greater effects depending on changes in water quality from No Name Creek and the accompanying water management strategies.

4.8.2. Land Disposal Alternatives

4.8.2.1. Alternative L1 – No Action

There would be no change to the current condition for aquatic habitat and fisheries resources on the selected or offered lands. The selected land would have 9.6 miles of suitable aquatic habitat for fish populations all of which is designated critical habitat for Chinook salmon (includes Thompson Creek, Buckskin Creek below mine disturbance, Pat Hughes Creek below mine disturbance, S. Creek, and Bruno Creek both above and below the TSF). There would be 5.4 miles of designated critical habitat for bull trout and steelhead in S. Creek and Thompson Creek.

The pond and associated culvert on lower Lyon Creek would continue to be an impediment to upstream fish passage and source of sediment, as well as the vehicle fords. There would continue to be distinct erosion/streambank sloughing in the lower 1,850 feet of Lyon Creek and use of the riparian corridor by livestock, along with little pool habitat and sparse riparian vegetation. The pond would impede the upstream migration and use of Lyon Creek by anadromous fish (e.g., Chinook salmon, steelhead) and fluvial migrants (e.g., bull trout, westslope cutthroat trout) such that there would continue to be effects on a population scale, in this case by reducing the distribution of these species. All fish habitat on the ranch would remain under private ownership, which would include 4.6 miles of designated critical habitat for Chinook salmon on Lyon Creek and 3.7 miles of the Salmon River, which is designated critical habitat for bull trout, Chinook salmon, sockeye salmon, and steelhead. For the Garden Creek property, fish populations would probably be small and/or not present and there would be no ESA-listed species or habitat on the property.

4.8.2.2. Alternative L2 – Land Exchange Proposal

There would be negligible effects to aquatic resources on the selected land (including special status species). The Thompson Creek and S. Creek Conservation Easement would prevent any meaningful disturbance to Thompson Creek or the Thompson Creek riparian corridor on the selected land, i.e., nothing would be allowed that would materially degrade the riparian values for which the easement was established. The easement would also prohibit the subdivision or residential development of S. Creek, and no other actions which could materially affect the S. Creek riparian area in the selected land are reasonably foreseeable. The BLM ranch management strategies relevant to aquatic resources would be the following:

- Lyon Creek would be managed with a focus on fisheries resources and any unscreened water diversions would be screened to prevent entrainment of downstream migrating fish;
- The pond near the Salmon River confluence would be removed to eliminate the barrier to upstream fish movement; and
- A portion of the ranch adjacent to the Salmon River would be rested from grazing and subjected to weed eradication.

Implementation of the Lyon Creek restoration plan would also improve riparian vegetation/pool habitat and reduce erosion, streambank sloughing, and sediment input to the lower 1,850 feet Lyon Creek, as well as exclude livestock grazing from the riparian corridor. Such would cause decreased water temperatures and improved fish habitat, thermal refuge for fish from the Salmon River, and fish passage in lower Lyon Creek. Screening of any unscreened diversions would prevent fish entrainment. Coupled with the removal of the pond, there would be increased habitat in the Salmon River system for bull trout, Chinook salmon, steelhead, and cutthroat trout. These species currently use the portion of Lyon Creek below the pond for thermal refuge and, in the case of steelhead, possibly for spawning (not confirmed). Any of the unscreened diversions along Lyon Creek that would still be used would be screened (long-term, beneficial, moderate effects). Resting portions of the ranch from grazing (BWR-7) would increase riparian vegetation along the Salmon River (negligible effect due to the small amount of rested area). Also, there would be a negligible effect to aquatic resources (e.g., less redd and streambank trampling or potential harassment of individual fish) due to the small amount of riparian area that could be accessed by livestock under Alternative L2. Further, some additional disturbance to individual fish and/or habitat could occur due to the public having access to what has historically been private property. Under Alternative L2-B the area of the ranch converted to native vegetation would not be grazed (negligible effect due to the small riparian area that would otherwise be accessible to livestock).

Under Alternative L2 the 9.6 miles of known or suitable aquatic habitat and designated critical habitat for Chinook salmon would leave Federal jurisdiction. However, approximately half (4.2 miles) of this designated critical habitat would be the lower portions of Buckskin Creek, Pat Hughes Creek, and Bruno Creek. These portions of the drainages are not occupied and could not be occupied by Chinook salmon in all but the most downstream reaches (i.e., movement upstream of the stream mouths is prevented by dewatering, sediment ponds, etc.) due to the use of these portions of the drainages as part of the water management system for the mine for the foreseeable future. The remaining 5.4 miles of the habitat would be Thompson Creek and S. Creek, which are designated critical habitat for steelhead and bull trout. These streams would be occupied by juvenile Chinook salmon, steelhead, and bull trout. In addition, these streams are larger and lower gradient than Lyon Creek, and might support spawning in the future. All of the aquatic habitat on the portion of Thompson Creek on the selected land would be protected by a conservation easement. The portion of the S. Creek easement area could not be subdivided or residentially developed, and no other actions which could materially affect the S. Creek riparian area in the selected land are reasonably foreseeable (negligible effect).

Under Alternative L2 the 4.6 miles of known or suitable aquatic habitat and designated critical habitat for Chinook salmon (Lyon Creek and Salmon River) on the Broken Wing Ranch would enter Federal jurisdiction. The 3.7 miles of this habitat along the Salmon River is also designated critical habitat for Chinook salmon, sockeye salmon, steelhead, and bull trout. The ranch would also provide the only effective access to 2.9 miles of fish habitat (also designated critical habitat for Chinook salmon) on Lyon Creek on BLM land upstream of the ranch (approximately 1.9 miles of which is known to currently support fish populations; with approximately 1 mile upstream of a seasonally dry reach). However, Lyon Creek is a smaller stream than Thompson Creek or S. Creek with a small watershed, narrow width, higher gradient along much of its length (the lower ¼-mile is lower gradient), and water use for agriculture. As a result, the value of Lyon Creek for fisheries may be less than the value of the fisheries in Thompson Creek and S. Creek. However, the fish habitat of Thompson Creek would be protected by a conservation easement, there could be no subdivision or residential development in the S. Creek riparian area in the selected land, and no actions that could materially affect the S. Creek riparian area in the selected land are reasonably foreseeable (negligible effects). Under Alternative L2-B the additional vehicles crossing the Lyon Creek ford would cause additional turbidity and sediment deposition for approximately 50 feet downstream (Section 3.8.2.2.) (long-term, negligible or minor effect). There would be no effects to aquatic habitat and fisheries resources at the Garden Creek property under Alternative L2.

4.8.2.3. Alternative L3 – Land Sale

The designated critical habitat on the selected land for Chinook salmon (9.6 miles) and suitable or currently occupied fish habitat (5.4 miles, designated critical habitat for Chinook salmon, steelhead, bull trout) would leave Federal jurisdiction, but would be protected by a conservation easement (no material effects could occur in the Thompson Creek riparian corridor in the selected land; no subdivision or residential development could occur in the S. Creek riparian corridor in the selected land; and no actions which could materially affect the S. Creek riparian corridor in the selected land are reasonably foreseeable) (negligible effect). The effects to the Broken Wing Ranch under Alternative L3 would not occur, e.g., removal of the impediment to fish movement on Lyon Creek would continue (long-term, negligible to moderate effects).

4.8.2.4. Alternative L4 – Reduced Area Land Exchange, Fee Simple

The selected land would contain only 500 feet of S. Creek instead of 2,500 feet under Alternative L2 (Figure 2.2-1), but all of the S. Creek riparian corridor that would leave Federal jurisdiction could not be subdivided or residentially developed, and no other actions which could materially affect the S. Creek riparian corridor in the selected land are reasonably foreseeable. Accordingly, 8.0 miles of aquatic habitat (including 3.8 miles of suitable fish habitat also designated critical habitat for Chinook salmon, steelhead, and bull trout) would leave Federal jurisdiction (negligible effect).

Regarding the offered lands, the subparcels on the ranch with the most valuable aquatic habitat would be BWR-1, BWR-2, and BWR-3 which include portions of Lyon Creek (Table 4.8-1). If the US would not acquire these subparcels, some of the beneficial effects to fish described for Alternative L2 would not occur (long-term, moderate effect). Rather, the effects would be the same as described for Alternative L1 or Alternative L3, but could be altered by IDFG work (e.g., new installations, repairs) on fish screens or removal of the pond. Some effects to aquatic habitat

could occur if the parcels adjacent to the Salmon River were acquired (BWR-4, BWR-6, and BWR-7), but the effects would be limited to a possible increase in riparian vegetation as described for Alternative L2 (negligible effect).

Table 4.8-1. Aquatic habitat at the Broken Wing Ranch.

Length of Habitat (miles)							
BWR-1	**BWR-2**	**BWR-3**	**BWR-4**	**BWR-5**	**BWR-6**	**BWR-7**	**TOTAL**
0.6	1.2	0.2	1.2	0.0	1.4	0.6	4.6

The sum of the mileage reported for the individual parcels is greater than the total due to some parcels containing the same portion of the Salmon River (i.e., opposite sides of the riverbank).

4.8.2.5. Alternative L5 – Reduced Area Land Exchange, Easement

The effects to the selected land would be the same as under Alternative L2, i.e., the only meaningful aquatic habitat on the selected land that would remain under Federal jurisdiction compared to Alternative L2 or Alternative L3 would be a short length (2,500 feet) of the S. Creek riparian corridor. However, none of this corridor on the selected land could be subdivided or residentially developed, and no actions which could materially affect this portion of the corridor are reasonably foreseeable. The effects to the offered lands would be the same as under Alternative L4.

4.9. Wetlands, Floodplains, and Riparian Areas

4.9.1. MMPO Alternatives

There would be direct effects and a potential for indirect effects to wetlands, riparian areas, and WUS[5] as a result of the MMPO alternatives. Tailings, waste rock disposal facilities, and other surface disturbances within the analysis area would cause direct effects by filling wetlands and stream channels which would cause a loss of wetland acreage and function. These effects would be major, permanent, and would occur immediately at the time of disturbance. Indirect effects would be caused by changes in hydrology downstream of the disturbances that could disrupt wetland hydrology and function.

TCMC diverts as much water around the mine facilities as is feasible. All water that contacts the facilities is potentially affected in quality and is therefore collected and typically used in the mill. Therefore, this water has not flowed into the Buckskin and Pat Hughes drainages for more than 30 years. As a consequence, some wetlands not directly destroyed (e.g., covered by waste rock) in these drainages may have been damaged or destroyed over the years due to decreases in water availability (baseline condition). The additional surface disturbance of the MMPO action alternatives would have only negligible effects on surface water quantity below the mine facilities under Alternative M2 and Alternative M3 (Section 4.6). A groundwater cutoff wall that will be installed as part of Phase 7 (Alternative M1 – No Action) at the Buckskin WRSF would

[5] There would not be any effects to floodplains (i.e. mapped 100 year floodplains) because these features are not present within the analysis area.

affect the amount of colluvial groundwater that flows downstream of the facility; however, the amount of colluvial groundwater captured would not change under the MMPO action alternatives. The groundwater cutoff walls installed at the Pat Hughes WRSF as part of the MMPO alternatives would reduce the amount of groundwater that discharges from beneath the Pat Hughes WRSF (Section 4.6); however, there were no wetlands identified downstream of the Pat Hughes WRSF. Therefore, there would not be any indirect effects to wetlands related to water quantity.

4.9.1.1. Alternative M1 – No Action

The wetlands within the current disturbed area at the mine, outside of the Mill Creek watershed, adjacent to linear features such as power lines, reclaimed roads, pipelines, fiber optic lines, and undisturbed areas in the vicinity of the WRSFs would not be affected. During reclamation there would be disturbance in the upper portion of the Mill Creek drainage that would affect up to 2.93 acres of wetlands in the drainage. However, the wetlands in the drainage were evaluated by the USACE for only disturbance under Alternative M2, i.e., the effects to wetlands in the drainage for Alternative M1 would not be known. Regardless, such effects would be less than the (fully evaluated) effects to wetlands that would occur in the drainage under the MMPO action alternatives.

4.9.1.2. Alternative M2 – MMPO as Submitted by TCMC

Alternative M2 and the Mill Creek reclamation/closure activities would result in the fill or burial of 3.39 acres of jurisdictional wetlands within the MMPO analysis area (Table 4.9-1). The majority of the wetlands affected consist of PEM wetlands followed by PFO wetlands and a small seep wetland. This would comprise direct effects to 74 percent of the jurisdictional wetlands in the Alternative M2 analysis area. This would be a permanent, major direct effect on wetlands within the analysis area. A wetlands mitigation plan (HDR 2014b) would be implemented by TCMC to mitigate these effects (Section 4.21.4. and Appendix B).

A total of 10,641 feet of stream length designated as WUS in the analysis area (34 % of the stream length in the analysis area) (Section 3.9.) would be filled by the WRSFs, inundated by the TSF, disturbed by the relocation of the Pat Hughes sediment pond, or disturbed during reclamation (Table 4.9-2.) (permanent, major effect). A 404(b)(1) alternatives analysis (HDR 2014a) would provide the USACE with the information necessary to determine whether Alternative M2 would comply with 40 CFR 230.10(a) of the 404(b)(1) guidelines (Appendix A). TCMC would implement a wetlands mitigation plan to mitigate the effects to wetlands (including stream channels) (Section 4.21., Appendix B).

Table 4.9-1. Effects to wetlands, Alternative M2.

Wetland ID (Figure 3.9-1.)	Affected[1] (acres)	Type[2]	JD[3]Status
PH Tributary Spring	0.05	PEM	Yes
PH1	0.21	PEM	Yes
BR2	0.032	PFO	Yes
WB1	0.025	PFO	Yes
WB2	0.108	PFO	Yes
WBWet1	0.004	PEM	Yes
WBWet2	0.003	PEM	Yes
Wetland1	0.036	PFO	Yes
MC1[4]	0.217	PEM	Yes
MC3[4]	0.21	PEM	Yes
MC4[4]	0.796	PEM	Yes
MC5[4]	0.127	PEM	Yes
MC6[4]	0.811	PEM	Yes
MC7[4]	0.153	PEM	Yes
MC8[4]	0.406	PEM	Yes
MC9[4]	0.203	PEM	Yes
MC Spring[4]	0.002	Spring	Yes
TOTAL	**3.39**		

[1] Due to the small size of the wetlands in the analysis area, if any portion of a wetland was in the analysis area the entire wetland was assumed to be affected (i.e. inundated, filled, or excavated).
[2] Cowardin et al. 1979
[3] jurisdictional determination
[4] Mill Creek drainage wetlands that would be disturbed under Alt. M2 and during reclamation.
BR = Bruno Creek; MC = Mill Creek; PH = Pat Hughes Creek; WB = West Fork Bruno Creek

Table 4.9-2. Effects to stream channels, Alternative M2.

Stream	Length Affected (feet)	Total length (feet)	Length Affected (%)
Buckskin Creek and tributary	0	4,118	0
Pat Hughes Creek and tributary	3,029	4,371	86
East Fork Pat Hughes Creek	0	3,971	0
No Name Creek	0	7,584	0
Bruno Creek, West Fork Bruno Creek, and tributaries	3,215	6,460	50
Mill Creek[1]	4,397	4,469	98
TOTAL	**10,641**	**30,973**	**34**

[1] Includes Mill Creek channel effects under Alternative M2 and during reclamation.

4.9.1.3. Alternative M3 – No Name Waste Rock Storage Facility

The type and area of wetlands affected would be nearly identical to Alternative M2, except for the inclusion of three additional wetlands due to the No Name WRSF: UN1 (PEM, 0.03 acre), UN2 (PEM, 0.02 acre), and UN Spring W1 (spring, 0.003 acre). There would be 3.44 acres of wetlands filled or buried in the analysis area (Table 4.9-3.), with effects to 74 percent of the jurisdictional wetlands in the analysis area (permanent, major effect). A total of 16,247 feet of the stream length designated as WUS in the analysis area (52 % of the stream length in the analysis area) would be buried by the WRSFs, inundated by the TSF, disturbed by relocation of the Pat Hughes sediment pond, or disturbed during reclamation (Table 4.9-4)(permanent, major effect). TCMC would implement a wetlands mitigation plan to mitigate these effects (Section 4.21., Appendix B).

Table 4.9-3. Effects to wetlands, Alternative M3.

Wetland ID	Affected[1] (acres)	Type[2]	JD[3] Status
PH Tributary Spring	0.05	PEM	Yes
PH1	0.21	PEM	Yes
BR2	0.032	PFO	Yes
UN1	0.03	PEM	Yes
UN2	0.02	PEM	Yes
UN Spring W1	0.003	Spring	Yes
WB1	0.025	PFO	Yes
WB2	0.108	PFO	Yes
WBWet1	0.004	PEM	Yes
WBWet2	0.003	PEM	Yes
Wetland1	0.036	PFO	Yes
MC1[4]	0.217	PEM	Yes
MC3[4]	0.21	PEM	Yes
MC4[4]	0.796	PEM	Yes
MC5[4]	0.127	PEM	Yes
MC6[4]	0.811	PEM	Yes
MC7[4]	0.153	PEM	Yes
MC8[4]	0.406	PEM	Yes
MC9[4]	0.203	PEM	Yes
MC Spring[4]	0.002	Spring	Yes
TOTAL	**3.44**		

[1] Due to the small size of the wetlands in the analysis area, if any portion of a wetland was in the analysis area the entire wetland was assumed to be affected (i.e. inundated, filled, or excavated).
[2] Cowardin et al. (1979)
[3] jurisdictional determination
[4] Mill Creek drainage wetlands that would be disturbed during reclamation.
BR = Bruno Creek; MC = Mill Creek; PH = Pat Hughes Creek; WB = West Fork Bruno Creek

Table 4.9-4. Effects to stream channels, Alternative M3.

Stream	Length Affected (feet)	Total Length (feet)	Length Affected (%)
Buckskin Creek and tributary	0	4,118	0
Pat Hughes Creek and tributary	3,029	4,371	86
East Fork Pat Hughes Creek	0	3,971	0
No Name Creek	5,606	7,584	74
Bruno Creek, West Fork Bruno Creek, and tributaries	3,215	6,460	50
Mill Creek[1]	4,397	4,469	98
TOTAL	**16,247**	**30,973**	**52**

[1] Includes Mill Creek channel effects under Alternative M2.

4.9.2. Land Disposal Alternatives

4.9.2.1. Alternative L1 – No Action

The 52 wetlands on the selected land (49.69 acres) would remain under Federal jurisdiction (Table 4.9-5). The 19 wetlands on the Broken Wing Ranch (36.98 acres) and the wetland on the Garden Creek property (0.7 acre) would remain in private ownership (Table 4.9-6).

4.9.2.2. Alternative L2 – Land Exchange Proposal

The wetlands on the selected land would be acquired by TCMC. Most (77 %; 38 acres) of the wetlands on the selected land would be within ⅛ mile of Thompson Creek and S. Creek, and could be only minimally disturbed due to the Thompson Creek and S. Creek Conservation Easement, and no actions which could materially affect the Thompson Creek or S. Creek riparian corridors are reasonably foreseeable, e.g., TCMC does not have any plans that would disturb any of the wetlands on the selected land (long-term, minor effects).

Table 4.9-5. Wetlands on the selected land, Alternative L2.

	Wetlands[1]						TOTAL By Ownership	
	Palustrine Emergent (PEM)		Palustrine Shrub-Scrub (PSS)		Palustrine Forested (PFO)			
Jdx.	(#)	(acres)	(#)	(acres)	(#)	(acres)	(#)	(acres)
BLM	30	5.81	19	40.04	3	3.84	**52**	**49.69**

[1] Cowardin et al. 1979

The wetlands on the offered lands would be acquired by the US: PEM (26.72 acres), PSS (9.57 acres), and PFO (1.39 acres) (Table 4.9-6). The BLM ranch management strategies would improve the riparian area adjacent to the Salmon River on the ranch by increasing the width of riparian vegetation (cottonwood, willow, forbs) with restoration and rest from grazing (long-term, moderate effect). There would be a net decrease of 12.01 acres of wetlands on BLM land. Under Alternative L2-B there would be no streambank trampling or damage to riparian vegetation from cattle at the gated Salmon River cattle crossing (long-term, minor effect).

Table 4.9-6. Wetlands on the offered lands, Alternative L2.

	Wetlands[1]						TOTAL By Ownership	
	Palustrine Emergent (PEM)		Palustrine Shrub-Scrub (PSS)		Palustrine Forested (PFO)			
Jdx.	(#)	(acres)	(#)	(acres)	(#)	(acres)	(#)	(acres)
Broken Wing Ranch	7	26.72	10	8.87	2	1.39	**19**	**36.98**
Garden Creek Property	0	0	1	0.70	0	0	**1**	**0.70**
TOTAL	**7**	**26.72**	**11**	**9.57**	**2**	**1.39**	**20**	**37.68**

[1] Cowardin et al. 1979

4.9.2.3. Alternative L3 – Land Sale

The same wetlands would leave Federal jurisdiction as for Alternative L2, but the US would not acquire the wetlands or riparian areas at the Broken Wing Ranch and Garden Creek property – a decrease of 49.69 acres of wetlands on BLM land. Riparian fencing and other riparian improvement/protection projects under the BLM ranch management strategies would not occur (long-term, moderate effect).

4.9.2.4. Alternative L4 – Reduced Area Land Exchange, Fee Simple

The selected land would contain only 500 feet of S. Creek instead of 2,500 feet under Alternative L2 (Figure 2.2-1). There would be 50 wetlands (21.72 acres) on the selected land: PEM (5.81 acres), PSS (12.07 acres), and PFO (3.84 acres) (Table 4.9-7). Approximately 35 percent of the wetlands would be within ⅛ mile of Thompson Creek, and would be protected by the Thompson Creek and S. Creek Conservation Easement (long-term, minor effect). TCMC does not have any current plans that would disturb wetlands on the selected land.

Table 4.9-7. Wetlands on the selected land, Alternative L4.

	Wetlands[1]							
	Palustrine Emergent (PEM)		**Palustrine Shrub-Scrub (PSS)**		**Palustrine Forested (PFO)**		**TOTAL**	
Jdx.	**(#)**	**(acres)**	**(#)**	**(acres)**	**(#)**	**(acres)**	**(#)**	**(acres)**
BLM	30	5.81	17	12.07	3	3.84	**50**	**21.72**

[1] Cowardin et al. 1979

There would be 37.68 acres of wetlands on the offered lands (Table 4.9-6). If the US acquired all of the offered lands there would be a net gain of 15.96 acres of wetlands on BLM land. However, there would be varying amounts of wetlands on the ranch subparcels (Table 4.9-8.) or the Garden Creek property (0.7 acre) that would not be acquired by the US (long-term, negligible to moderate effects). For example, if BWR-1 was not acquired by the US, 21.46 acres of wetlands (58 % of all wetlands on the ranch) would remain in private ownership (long-term, moderate effect).

Table 4.9-8. Wetlands on the Broken Wing Ranch, Alternative L4.

Jdx.	Wetlands[1]						TOTAL[2]	
	Palustrine Emergent (PEM)		Palustrine Shrub-Scrub (PSS)		Palustrine Forested (PFO)			
BWR-1	**ID**	**(acres)**	**ID**	**(acres)**	**ID**	**(acres)**	**(#)**	**(acres)**
	1A	0.44	1	1.20	3	0.50	**8**	**21.46**
	2	15.72	9	0.05				
	2A	2.38						
	2B	0.77						
	2C	0.40						
BWR-2			4	0.04	3	0.25	**4**	**1.09**
			8	0.76	10	0.04		
BWR-3			11	0.01	3	0.25	**3**	**0.61**
					10	0.35		
BWR-4	6A	6.70	7A	0.70			**6**	**10.5**
	6B	0.31	7B	0.26				
			8	1.52				
			12	1.17				
BWR-5							**0**	**0**
BWR-6			8	1.26			**1**	**1.26**
BWR-7			5	1.41			**2**	**1.91**
			8	0.50				
TOTAL	**7**	**26.72**	**12**	**8.87**	**5**	**1.39**	**24**	**36.98**

[1] Cowardin et al (1979)
[2] Wetlands were counted more than once when they extended into another subparcel.

4.9.2.5. Alternative L5 – Reduced Area Land Exchange, Easement

The same wetlands on the selected land would leave Federal jurisdiction as for Alternative L2 and Alternative L3, except the wetlands (~ 0.5 acre) within a short length (2,500 feet) of the S. Creek riparian corridor and the wetlands (~ 0.16 acre) on the 1,500 acres. However, all of the wetlands on the selected land would be protected by the conservation easement on the 1,500 acres or the Thompson Creek and S. Creek Conservation Easement, except for the wetlands within ⅛ mile of the S. Creek riparian corridor on the selected land. However, there would be no subdivision/residential development in the S. Creek riparian corridor, and no actions which could materially affect the Thompson Creek and S. Creek riparian corridors on the selected land are reasonably foreseeable (negligible effect). Depending on the offered lands acquired by the US, the BLM would probably gain jurisdiction of most of the wetlands on the offered lands: slightly more than under Alternative L4, and slightly less than under Alternative L2 (37.68 acres, Table 4.9-6.) (long-term, minor effect).

4.10. Air Quality, Noise, and Climate Change

4.10.1. MMPO Alternatives

4.10.1.1. Alternative M1 – No Action

Air Quality

Air quality emission inventories and computer simulations from pollutant dispersion models demonstrate the maximum concentrations (including background concentrations) of criteria air pollutants at the perimeter of the mine would exceed SILs (minimal impact levels) for only PM_{10}, nitrogen dioxide and sulfur dioxide, but the maximum concentrations would reach only 60 percent of the NAAQS for PM_{10} and less than 17 percent of NAAQS for sulfur dioxide and nitrogen dioxide. The results also demonstrate that the concentrations of all criteria pollutants would be below the SILs at the Thompson Creek and S. Creek roads, and all areas of regular human activity (IDEQ 2008).

After mining, the amounts of mine-generated criteria air pollutants would decrease somewhat proportional to the decrease in workers during the reclamation stages. In addition, improved technology would be expected to continue to reduce pollutants from equipment emissions. Regardless, after core reclamation, the concentrations of pollutants would be essentially those of the background (no mining) condition, which would be less than those of the pre-mine condition (1980) due to improvements in technology to reduce these pollutants from industrial and vehicle emissions, the removal of lead and substantial decrease in sulfur from vehicle fuels, and the relatively small increase in non-mining vehicle emissions or other source emissions in the analysis area since 1980. The PM_{10} generated from the waste rock and TSF during mining, even without vegetation, would be comparable to or less than the pre-mine condition due to the relatively coarse materials. Once capped, the WRSFs would generate approximately 15 percent more annual PM_{10} compared to during mining, until vegetation was established during late-stage reclamation when the PM_{10} from wind erosion would be comparable to the pre-mine condition.

There would be no substantial quantities of criteria pollutants generated by off-site, mine-related vehicle traffic due to the relatively few vehicles involved, the relatively large areas in which the pollutants would be generated, and the relatively small quantities of generated pollutants. The largest quantity of pollutants would be from fugitive dust on the unpaved Thompson Creek and S. Creek roads. However, there would be very little mine-related traffic on Thompson Creek Road (Section 4.16.), and such traffic would be at very low speeds, e.g., less than 20 mph. The S. Creek Road has relatively low (~ 3 %) silt content from many years of use, and TCMC would continue to maintain the surface on the road with magnesium chloride. Therefore, the fugitive dust that would be generated from S. Creek Road during mining would probably be less than or comparable to the pre-mine condition, even considering the additional mine-related traffic. Regardless, people traveling on S. Creek and Thompson Creek roads may occasionally encounter a small, light-colored dust cloud from mine-related traffic. These clouds would be up to approximately 100 feet in diameter perpendicular to the roads, up to approximately 500 feet in length behind a vehicle, and would disperse within at most a minute or two, typically after traveling less than 500 feet. There would be no meaningful off-site fugitive dust.

There would be no meaningful effects to wildlife due to criteria pollutants in the analysis area, i.e., transient nature of most wildlife would result in less exposure to criteria pollutants than people working or living in the analysis area. There would be no potential for a substantial natural or human-caused wildfire at the mine during mining due to the lack of vegetation at the site and safety policies enforced at the mine. Despite fire prevention/suppression programs at the mine, there would continue to be a very slight probability of a substantial, human-caused wildfire near the mine (including on the selected land that is not part of the mine) due to operations near the perimeter of the mine in and adjacent to native vegetation cover, or due to non-TCMC personnel in the area. There would be a slight probability of a substantial (natural or human-caused) wildfire at the mine after revegetation from reclamation because of the decrease in workers and equipment available on-site for rapid fire suppression. The probability of such wildfire would be comparable to that on the selected land (that is not part of the mine) or that of pre-mine conditions.

Noise

Sound levels at the mine would continue to vary from about 35 dBA L_{DN} (e.g., at the edges of the operational area such at the north end of the TSF) to 105 dBA L_{DN} in certain noisy work areas (e.g., the operator position for the gyratory crusher). However, compliance with current mine safety procedures would ensure that TCMC employees or visitors to the mine would not be exposed to noise above regulatory limits.

The main sources of ambient sound in the analysis area would continue to be from wind, flowing water, birds and insects. Sound levels in the ambient portion of the analysis area would continue to be approximately 30 dBA L_{DN} in the quietest areas up to approximately 55 dBA L_{DN} in areas near flowing water or windy locations. Mine-generated sound might be heard by people or wildlife within approximately 1,000 feet (or only a few hundred feet when trees would be abundant) of the perimeter of the mine. In such case, these receptors may occasionally hear faint sounds from heavy equipment operating at the mine perimeter, e.g., a vehicle back-up warning signal in the Pat Hughes Creek drainage. All other human receptors would generally be shielded from mine-generated sound (and blasting vibrations) by intervening ridges and distance. For

example, people traveling on Thompson Creek Road would not hear WRSF activities in the Pat Hughes Creek drainage, and mine-generated sound would not be audible at residences in the analysis area, most of which would also be buffered by sound from nearby flowing water and non-mining vehicle traffic on nearby roads.

The increase in the sound level 50 feet from SH 75 from mine-related, highway traffic during molybdenum production would continue to be negligible (1.8 dBA). Mine-related sound would decrease somewhat proportional to the decrease in workers during the reclamation stages, and by late-stage reclamation would be at pre-mine levels, e.g., 30 to 55 dBA L_{DN}. Wildlife at or within 1,000 feet of the mine would experience mine-generated sound, but would not be meaningfully affected by such sound, e.g., deer commonly forage adjacent to highways, elk commonly graze at the mine, and a black bear has casually wandered into the pit; the transient nature of wildlife is such that wildlife would not remain at or near the mine if disturbed by noise. A more detailed evaluation of the potential effects to wildlife from mine-related noise is in the wildlife resources section (Section 4.7).

4.10.1.2. Alternative M2 – MMPO as Submitted by TCMC

The effects on air quality would be essentially the same, except that they would occur for 9 years longer and there would be an increase of 2.6 and 2.0 percent, respectively, of the annual PM_{10} and $PM_{2.5}$ generated from the additional area of TSF (82 acres) and WRSFs (252 acres) (TCMC 2012c). These increases would have negligible effects on the most sensitive human receptors. The ambient air analysis area would be the same because none of the proposed expansion would increase the restricted mine area. The probability of a mine-related wildfire would be comparable to that under Alternative M1.

Similar to air quality, the effects of noise would be essentially the same except would occur for a longer duration. The toe of the Pat Hughes WRSF would gradually extend an additional 1,400 feet south down the drainage. However, even at its farthest extension the toe would be 2,640 feet from Thompson Creek Road, and the closest equipment on the lowermost bench would be 3,990 feet from road. Therefore, even bulldozers with a maximum sound level of 87 dBA at 50 feet would not be audible to someone walking on Thompson Creek Road near the mouth of Pat Hughes Creek.

4.10.1.3. Alternative M3 – No Name Waste Rock Storage Facility

The effects on air quality and of noise would be essentially the same as under Alternative M1 and Alternative M2. The construction of a new WRSF (237.5 acres) in the No Name Creek drainage would generate approximately 26 tons of PM_{10} during construction activities lasting a few weeks. Thereafter, at its maximum size, the facility would generate approximately 20 tons of PM_{10} annually. These amounts of PM_{10} and $PM_{2.5}$ would not affect the most sensitive receptors. The increase in pollutants from equipment emissions during the construction of the facility would similarly be negligible. The same would be true for the decrease of approximately 5 to 10 percent in pollutants due to shorter, waste rock haul distances using the No Name facility compared to Alternative M2. The ambient air analysis area would also be reduced by 1.1 percent. The effects of noise would be essentially the same as Alternative M1 and Alternative M2. Sound from heavy equipment at the No Name facility would not be audible

along Thompson Creek Road, which would be a minimum of 1,600 feet from the toe of the final configuration of the No Name facility.

4.10.2. Land Disposal Alternatives

4.10.2.1. Alternative L1 – No Action

The ambient air quality of the analysis areas for the selected and offered lands would be within the NAAQSs for all criteria pollutants. The SILs for mine-generated PM_{10}, nitrogen dioxide, and sulfur dioxide would be exceeded at the selected land within the perimeter of the mine, but would not be exceeded in the vicinity of any sensitive receptors in the analysis area, or along S. Creek or Thompson Creek roads. Mine-generated pollutants and their effects to the most sensitive receptors (none at the selected land) would be the same as described for the MMPO alternatives. The offered lands would continue to have excellent air quality, with negligible emissions of fugitive dust at the Garden Creek property and emissions of fugitive dust at the Broken Wing Ranch typical of the agriculture and cattle ranches in the region, even if limited residential development were to occur.

Ambient sound levels in the analysis area for the Broken Wing Ranch would continue to be approximately 45 to 50 dBA and 35 dBA L_{DN} within 50 feet and 300 feet, respectively, of the highway, comparable to typical outdoor sound levels of 35 to 50 dBA L_{DN} for rural areas. Limited residential development at the ranch would not noticeably (> 3 dBA L_{DN}) increase the average sound level of the analysis area for the ranch.

Ambient sound levels in the analysis area for the Garden Creek property would be approximately 30 to 40 dBA L_{DN}. Vehicle traffic in the analysis area would be extremely rare. There would occasionally be air traffic over the property due to the small Pocatello airport approximately 10 miles to the north. Such overflights would have short-term effects up to approximately 60 dBA L_{DN} a few times per day. Limited residential development at the ranch would not noticeably increase the average sound level of the analysis area.

4.10.2.2. Alternative L2 – Land Exchange Proposal

There would not be increased sound levels and criteria pollutants from limited residential development (e.g., vehicle emissions and sound, fugitive dust from vehicles, wood stoves, typical residential sounds) that would probably occur under Alternative L1. However, there would be increased sound levels and pollutants from dispersed public recreation (e.g., emissions, sounds, and fugitive dust from vehicles; typical recreational sounds). No pollutants/sound would be generated from public vehicles in the drainage. However, the greater number (few hundred per year) of dispersed recreationalists would cause increased dust clouds from vehicle traffic on the main access road through the ranch, primarily during the summer when traffic would be greatest and the ground would be driest, and to a lesser extent during the fall hunting season. The dust clouds would be a few hundred feet in diameter, would disperse in less than 1 minute, and would not reach residences outside of the ranch. Similar dust clouds, but with a lower frequency and diameters up to approximately 1,000 feet, would continue to be generated during high winds from agricultural plowing (long-term, minor effects). There would be dust clouds that could reach adjacent property, particularly on windy days, if motorized use was allowed on the Challis East Subdivision Trail (long-term, minor effect for aesthetic reasons). However,

there would not be an increase in the concentrations of any criteria pollutant of more than its SIL at any residence in the analysis areas for the selected and offered lands (negligible effect).

There would not be an increase of 3 dBA L_{DN} or more in these analysis areas, except approximately within 25 feet of the main access road of the ranch (~ 3 to 6 dBA L_{DN}) during periods of greatest use, and within 50 feet of the ranch houses if the areas outside the houses were being used by a large group of people (~ 3 to 6 dBA L_{DN}). The development of a campground would cause a similar increase in sound level within approximately 100 feet of the campground (long-term, minor effects). The Challis East Subdivision Trail would cause an increase in sound levels (~ 3 to 10 dBA L_{DN}) at some of the adjacent properties if motorized use was allowed on the trail (long-term, minor to moderate effect). Under Alternative L2-B there would be a similar increase in sound level in the Lyon Creek drainage from vehicles (long-term, minor effect). After the initial plowing as part of the conversion to native vegetation, there would not be dust clouds from agricultural plowing (long-term, minor effect).

4.10.2.3. Alternative L3 – Land Sale

There would be the same effects as for Alternative L1.

4.10.2.4. Alternative L4 – Reduced Area Land Exchange, Fee Simple

There would be essentially the same effects as for Alternative L2 (long-term, negligible to minor effects).

4.10.2.5. Alternative L5 – Reduced Area Land Exchange, Easement

The conservation easement on approximately 1,500 acres of the selected land would preclude any meaningful increases in pollutants or sound from the area, but no such increases are reasonably foreseeable for the area. Therefore, the effects would be essentially the same as for Alternative L2 (long-term, negligible to minor effects).

4.10.3. Climate Change

There would not be any meaningful effects from the land disposal alternatives to climate change; therefore, only potential effects from the MMPO alternatives to climate change are discussed. The emissions of GHGs for the MMPO alternatives are compared to the emissions of Idaho, a portion of the Northern Rocky Mountains region, the US, and the world to provide an understanding of the relative amount of the emissions of the alternatives (Table 4.10-1).[6] However, the effects of the MMPO alternatives on climate change should be evaluated only by comparing the emissions of GHGs (as CO_2e) of the alternatives with the emissions of Idaho, the region, and the world, because certain GHGs have atmospheric lifetimes of years and are therefore well mixed and transported in the atmosphere.

[6] The CEQ (2010) has defined 0.025 MT/year of direct emissions of GHGs as a de minimis amount for the purposes of NEPA analysis.

Table 4.10-1. Summary of emissions of GHGs (MT CO_2e).

Area or Alt.	2009	2016	2017	2020	2025	2026	2027	2030	2035
M1	0.049	0.049	0.024	0.002	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
M2	0.049	0.049	0.049	0.049	0.049	0.049	0.024	0.002	< 0.001
M3	0.049	0.049	0.049	0.049	0.049	0.049	0.024	0.002	< 0.001
Idaho[1]	38	41	41	43	45	46	46	48	51
Region[1]	135	159	163	175	197	202	206	221	249
US[2]	6,768	6,420	6,371	6,229	5,999	5,954	5,909	5,777	5,563
World[3]	57,811	62,727	63,463	65,722	69,455	70,227	71,007	73,400	77,569

[1] post-2009 estimated using the average annual increase projected during 2009 to 2020
[2] post- 2009 estimated using the average annual increase during 2000 to 2009
[3] post-2009 estimated by interpolation of the A2 emissions scenario (Nakićenović et al. 2000) with IPCC (2007) $GWPs_{100}$

4.10.3.1. Alternative M1 – No Action

The annual estimated emissions of GHGs of the mine during mining are and would continue to be 0.049 MT (Table 4.10-1.), which would be a negligible component of the world emissions of GHG. Direct emissions of GHGs would occur from the onsite TCMC vehicle fleet that would result from hauling and placing waste rock on Federal land, but these would not be substantial enough to cause an effect to climate change on any scale. During core reclamation there would be no emissions of GHGs from ore extraction, waste rock storage, ore processing, tailings storage, and shipments of ore to the Pennsylvania roasting plant. Emissions from stationary combustion (boilers) would also be reduced to only that from space heating. In addition, the emissions of GHGs from the onsite vehicle fleet, shipments to the mine, and commuter and contractor traffic would decrease by approximately 50 percent. Therefore, the emissions of GHGs of the mine would continue to a negligible component of Idaho, the region, US, and world emissions of GHGs during core, late-stage, and long-term reclamation (Table 4.10-1).

4.10.3.2. Alternative M2 – MMPO as Submitted by TCMC

The annual emissions of GHGs would be essentially the same as those under Alternative M1, except the emissions during mining would occur through 2025 instead of only 2016, followed by essentially the same emission patterns during reclamation as under Alternative M1 (Table 4.10-1).

4.10.3.3. Alternative M3 – No Name Waste Rock Storage Facility

The construction of an additional WRSF facility in the No Name Creek drainage would not cause any substantial changes to the annual emissions of GHGs from the mine as compared to Alternative M1 and Alternative M2. That is, there would be a negligible increase in the emissions of GHGs due to longer haul distances (Table 4.10-1).

4.10.3.4. Effects of Climate Change on the MMPO Alternatives

Regarding the potential effects of climate change on all of the alternatives, there are dozens of models that provide different, general, climate change scenarios for various emissions scenarios, e.g., the average annual precipitation worldwide or for a major region. However, none of the models may be scaled down to the spatial level of the mine site or even the region of the mine with a certainty that would allow meaningful evaluation of site-specific future effects due to climate change, or the evaluation of potential mitigation of such effect. In addition, the appropriate emissions scenario is unknown. In short, "Any study of climate change and its impacts at the regional scale is fraught with uncertainties" (Whetton et al. 1993, p. 291), and "specific, local outcomes of climate change are uncertain" (IPCC 2012, p. 29).

Assessing future extreme weather events is far more uncertain, e.g., "There is limited to medium evidence available to assess climate-driven observed changes in the magnitude and frequency of floods at regional scales because the available instrumental records of floods at gauge stations are limited in space and time, and because of confounding effects of changes in land use and engineering. Furthermore, there is low agreement in this evidence, and thus overall *low confidence* at the global scale regarding even the sign of these changes" and "It is *likely* [less than 66 %] that the frequency of heavy precipitation or the proportion of total rainfall from heavy rainfalls will increase in the 21st century over many areas of the globe. This is particularly the case in the high latitudes and tropical regions, and in winter in the northern mid-latitudes...For a range in emission scenarios (SRES A2, A1B, and B1), a 1-in-20 year annual maximum 24-hour precipitation rate is *likely* to become a 1-in-5 to 1-in-15 year event by the end of the 21st century in many regions..." (IPCC 2012, p. 112-113). In addition, the foremost authority on precipitation frequency analysis – the NOAA – conducts such analysis based on a stationary climate because 1) statistical tests to identify statistically significant trends in the annual maximum series of observations used in the frequency analysis do not show meaningful observable or geographically consistent temporal change in these data, and 2) the effect of potential changes in climate on precipitation frequency estimates is uncertain (NOAA 2013b).

Such general inferences from computer simulations may be used to guide further research or examine worst-case scenarios at the global or regional scale, but are far too speculative for use in site-specific engineering. Therefore, state-of-the-industry engineering is still based on historic climate records and not on computer climate simulations. For example, ports worldwide are currently designed for historic (typically 100 year) flood events (Becker et al. 2012), and water diversion ditches at the mine would not be designed with smaller capacities if climate simulations suggested less intense storms than historic records for the region.

It is difficult to assess the risk (probability and consequence) of uncertainties in climate change effects to the alternatives because the accuracy of the climate simulations of the models is unknown. For example, 100 year simulations for the western US from a selection of 21 regional climate models project an increase in average annual global temperature ranging from 2.1 °C (3.8 °F) to 5.7 °C (10.3 °F), and an average annual precipitation ranging from a *decrease* of 3 percent to an *increase* of 14 percent. These ranges were generated for a single, medium emissions scenario. Using some of the higher and lower emissions scenarios would have generated an even wider range of projected temperature and precipitation (Christensen et al. [IPCC] 2007). In addition, a recent evaluation for the last 15 years (1998 to

2012) of 117 simulations from 37 CMIP5 models yielded a trend of 0.21 °C (0.38 °F) ± 0.03 °C (0.05 °F) per decade, more than four times larger than the measured trend of 0.05 °C (0.09 °F) ± 0.08 °C (0.14 °F) per decade at the 95 percent (widest) confidence intervals (Fyfe et al. 2013). That is, the results of computer simulations are currently substantially different than measured values, even for the simplest parameter – global average surface temperature.

Regardless, increasing the average annual precipitation by 14 percent would not cause catastrophic failure of the pit walls, WRSFs, or the TSF, but increasing the annual temperature at the mine by 5.7 °C would cause long-term, major effects including dramatic changes in vegetation patterns and wildlife ranges. However, under such circumstances humans would probably be dealing with catastrophic famine and the collapse of societies. Regarding the uncertainty of extreme weather events, projections of climate change suggest increasing temperatures and intensified precipitation patterns across the US (Christensen et al. [IPCC] 2007; Kollat et al. 2012). These projections in a worst-case scenario suggest a 20 year/24 hour storm (5 % chance of occurrence in any year, 64 % chance of occurrence at least once in 20 years) could occur every 5 years (20 % chance of occurrence in any year, 99 % chance of occurrence at least once in 20 years) (IPCC 2012 – Figure SPM.4B., W. North America). Similarly, Kollat et al. (2012) infer a worst-case increase at the end of the 21st century of approximately 10 percent in 100 year flood discharges for the Northern Rocky Mountains, but caution that such inferences should not be considered as projections for specific regions or used to redraw flood maps.

Increased frequency of storms or an increase in the quantity of a 100 year flood discharge would be expected to cause proportional increases in erosion in all areas experiencing storms/floods, and in the frequency that the diversion ditches at the mine would not contain all flow. However, such increased surface run-off would not cause any catastrophic failures at the mine site, e.g., the reclaimed TSF would safely contain the 96 hour probable maximum precipitation for the site (substantially more than the run-off that would be generated in a 100 year storm event predicted by the historical record).

4.11. Visual (Aesthetic) Resources

4.11.1. MMPO Alternatives

4.11.1.1. Alternative M1 – No Action

There would be no new meaningful effects during mining or after reclamation (Photo 4.11-1., before reclamation). Therefore, the only effect to visual resources would be the continued mine lighting on dark night skies until 2016 (Section 4.11.2).

Photo 4.11-1. View from KOP 1, Alternative M1.

4.11.1.2. Alternative M2 – MMPO as Submitted by TCMC

The annual mining activity would be similar, but the incremental enlargement of the WRSFs and TSF might be noticeable from most of the KOPs (short-term effects). The overall enlargement would probably be noticeable from all of the KOPs (long-term effects).

KOP 1 – Custer Lookout

All of the disturbance that would be visible from KOP 1 would be on NFS land from the Upper Buckskin WRSF and the re-aligned power line (Photo 4.11-2., before reclamation). The Upper Buckskin WRSF would gradually expand on the north side of the mine. In the long term after mining, the disturbance (thin light tan or white line) would be widened and would have greater contrast with the surrounding dark greens and blues of the conifer forest. Observers who had seen the mine prior to Alternative M2, might notice the difference, but the effect would be minor from KOP 1. Changes over a few years would not generally be noticeable to the casual observer.

The re-aligned power line might be visible from KOP 1 as a faint diagonal line extending from the ridge behind the Buckskin WRSF down to the edge of the pit, and the removal of trees and shrubs along the power line corridor would create a color contrast with the surrounding conifer vegetation. The disturbance might be more noticeable in the short term just after construction (fresh disturbance and lack of understory vegetation). Once ground cover vegetation is re-established in the corridor, the corridor would be visible as a different color of vegetation, but might not be noticeable from KOP 1 considering the magnitude of the overall existing visual effects to the landscape of the mine. The NFS visible land from KOP 1 is designated VQO Modification. The BLM land visible from KOP 1 is designated VRM Class III (partial retention).

In the short term, the effect from KOP 1 would be a negligible, incremental change in the size of the WRSFs. Given the complex landscape surrounding the mine (multiple lines, variation in color and texture), the effect would be minor and long-term, and would meet the VQO Modification and VRM Class III designations. Reclamation of the WRSFs would reduce the contrast of the mine in the landscape from KOP 1.

Photo 4.11-2. View from KOP 1, simulation for Alternative M2.

KOP 2 – No Name Creek Drainage

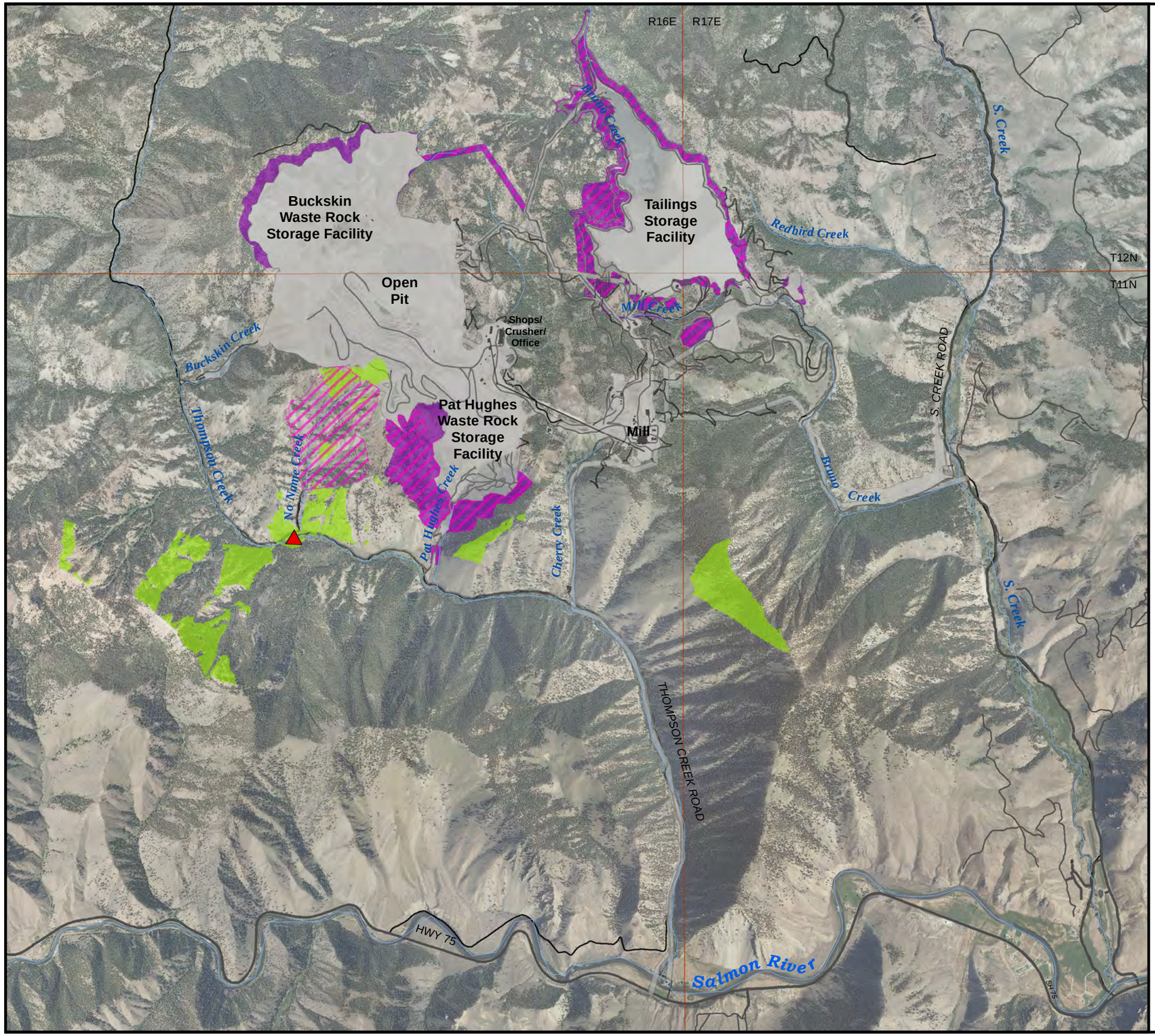
There would be no effects from KOP 2 (Figure 4.11-1).

KOP 3 – South Butte

The majority of the existing TSF occurs on NFS land designated as VQO Modification. A small portion of the southwest corner of the existing facility occurs on BLM land designated VRM Class III. The disturbance from the TSF would affect both NFS and BLM lands (Photo 4.11-3., Photo 4.11-4., both before reclamation).

Photo 4.11-3. View from KOP 3, Alternative M1.

Photo 4.11-4. View from KOP 3, simulation for Alternative M2.



Legend

- Existing mining disturbance
- MMPO areas/Alternative M2
- MMPO areas/Alternative M3
- Stream
- 2WD road
- Primitive road
- KOP 2
- Visible from KOP 2

N

1 1:44,000 0

Miles

0 1

Kilometers

Selected land, existing mining disturbance, and Phase 8 expansion areas from Thompson Creek Mine data, polygons created by Ken Gardner.
Viwshed Analysis by Connie Pixton, JBR Environmental Consultants, Inc.
Imagery NAIP 2009
Coordinate system UTM Zone 11 NAD 83

Figure 4.11-1
KOP 2, No Name Creek drainage viewshed analysis
Thompson Creek Mine EIS

Under Alternative M1 the TSF embankment would be conspicuous in the landscape (Photo 4.11-3., before reclamation). The light tan to pale gray color of the embankment face would contrast distinctly with the brown to dark green, almost black, vegetated mountain slopes. Under Alternative M2 there would be a larger area of light color in the midst of the darker colors (Photo 4.11-4., before reclamation). The horizontal line at the top of the embankment would be slightly lengthened and the increased height of the face of the embankment would be somewhat noticeable, largely because of the color contrast. The changes in the embankment would possibly be noticeable to viewers familiar with the landscape from KOP 3, but would not essentially change the visual relationship between the embankment and the landscape. The changes would also occur during a number of years, reducing the noticeability of the changes to the casual observer. In the short term, effects to visual resources from KOP 3 would be negligible due to the relatively small, incremental change in the size of the TSF. At the end of mining, there would be a long-term, minor effect from the facility, but the VQO Modification and VRM Class III designations would be met (the TSF would not dominate the view).

Reclamation would include recontouring the embankment to create benches every 100 feet in vertical elevation, covering the face with growth media, and revegetating. Ultimately mature vegetation similar to that of the surrounding area would help reduce the contrast of the embankment face in the landscape from KOP 3, but the embankment would still be expected to be readily seen by the casual observer from the KOP.

KOP 4 – Highway 75

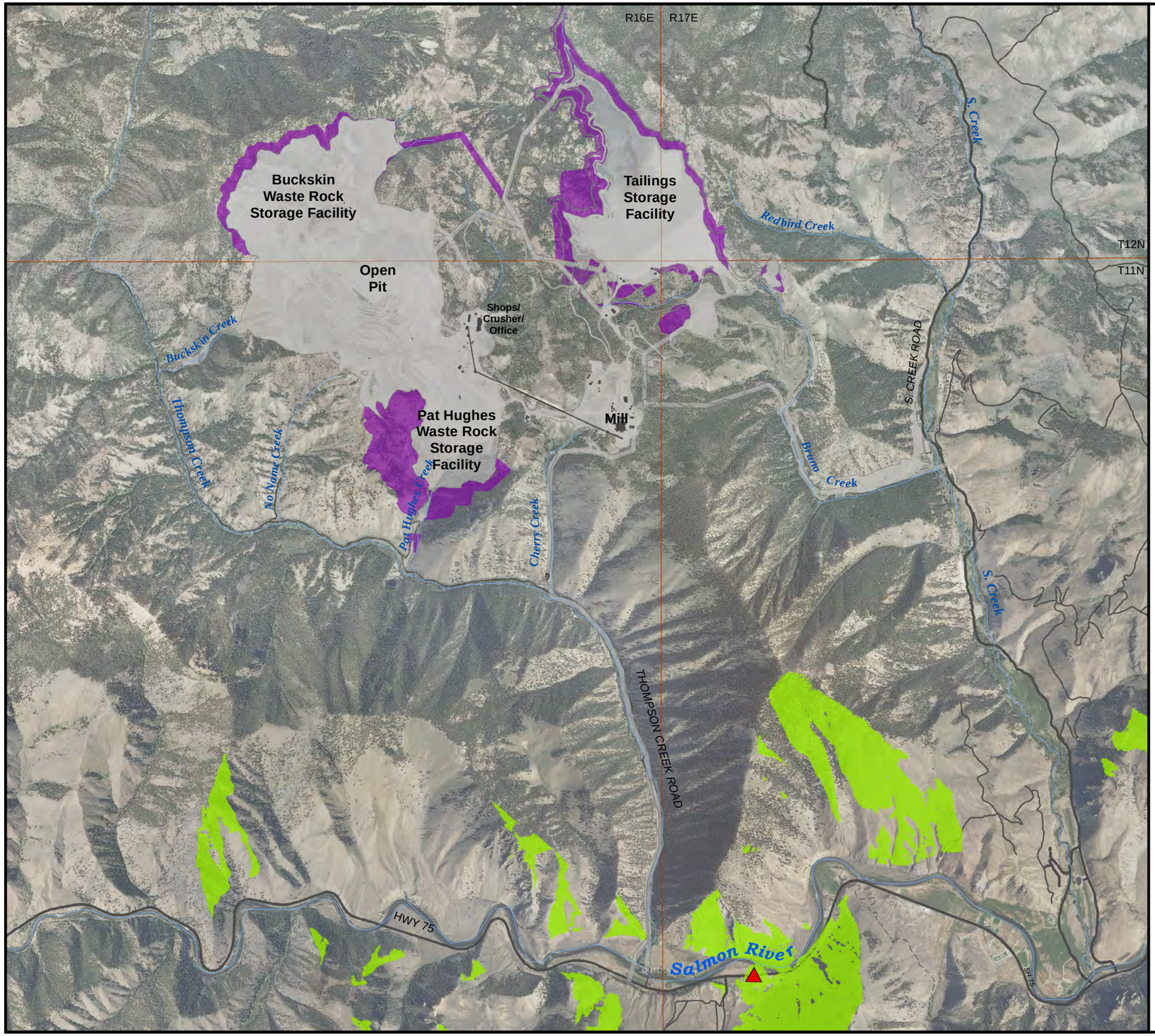
A viewshed analysis of KOP 4 representing views from SH 75 shows that the mine would not be visible under Alternative M1 or Alternative M2 from KOP 4 (Figure 4.11-2.), i.e., there would be no effect to visual resources from KOP 4.

KOP 5 – Railroad Ridge

All of the effects from KOP 5 would be on NFS land due to expansion of the Upper Buckskin WRSF and a portion of the TSF (Photo 4.11-5., Photo 4.11-6., both before reclamation). The areas of the facilities are designated VQO Modification.

Photo 4.11-5. View from KOP 5, Alternative M1.

Photo 4.11-6. View from KOP 5, simulation for Alternative M2.



Legend

- Existing mining disturbance
- MMPO areas/Alternative M2
- Stream
- 2WD road
- Primitive road
- Trail

Viewshed Analysis

- KOP 4
- Visible from KOP 4

N

1 0 1:44,000 Miles

0 1 Kilometers

Selected land, existing mining disturbance, and Phase 8 expansion areas from Thompson Creek Mine data, polygons created by Ken Gardner.
Viwshed Analysis by Connie Pixton, JBR Environmental Consultants, Inc.
Imagery NAIP 2009
Coordinate system UTM Zone 11 NAD 83

Figure 4.11-2
KOP 4, Highway 75 viewshed analysis
Thompson Creek Mine EIS

The only mine features that would be visible from KOP 5 under Alternative M1 would be a portion of the pit, the Upper Buckskin WRSF and a portion of the top of the TSF; topography blocks views of the remainder of the mine development (Photo 4.11-5., before reclamation).

The majority of the effects from KOP 5 would be from the Upper Buckskin WRSF, with an expanded area of light tans and browns which would somewhat increase the appearance of the size of the mine in the landscape. The TSF embankment would be less conspicuous and barely noticeable in the landscape as the colors of the embankment face would be of similar scale and color to the surrounding patchy landscape. The expansion of the TSF would occur in very small increments over a number of years, which would reduce the noticeability of the change to the casual observer. In the short term, the effects from KOP 5 would be a negligible incremental change in the size of the mine surface disturbance. In the long term, there would be minor effects from the Upper Buckskin WRSF and TSF embankment. However, the area would continue to meet the VQO Modification designation as the perceptible visual changes would be minor.

Revegetation of the WRSF would soften the appearance of the topography and blend with the surrounding vegetation as viewed from KOP 5. At full maturity, revegetation of the facility would greatly reduce the effect from KOP 5, and might even prevent the embankment face from being seen from KOP 5. The portion of the uppermost pit visible would remain visible after reclamation.

KOP 6 – Pat Hughes Waste Rock Storage Facility

The effects from KOP 6 would be on BLM land due to expansion of the Pat Hughes WRSF (Photo 4.11-7., Photo 4.11-8., both before reclamation). The facility is on land designated VRM Class II and III, but the expansion of the facility would be on land mostly designated VRM Class II.

The light yellow-white to tan and gray colors of the facility would distinctly contrast with the surrounding darker land and vegetation. The texture of the waste rock would be somewhat coarse, but distinctly less coarse than that of the surrounding vegetation. The facility would expand in three dimensions making it appear taller, wider, and closer to the viewer. The area of light-colored waste rock would distinctly contrast with the surrounding darker colors. The horizontal line at the top of the facility would be lengthened to dominate the more subtle diagonal lines of the slopes of the enclosed landscape. The horizontal line would also be highlighted due to a second horizonal line where the foreground meets the gentle slopes of the middle ground. Rough, creased land forms in the background would be obliterated or obscured with greater uniformity to the view. Because the face of the facility would be closer to the viewer, more texture would be visible on the face than under Alternative M1. After mining the level of change to the landscape from the facility would be moderate and long-term; the activity would clearly attract the attention of the viewer with facility dominating the landscape from KOP 6.

Photo 4.11-7. View from KOP 6, Alternative M1.

Photo 4.11-8. View from KOP 6, with simulation of the Pat Hughes WRSF.

In the short term, effects from KOP 6 would be minor incremental changes in the size of the WRSF. After mining there would be a long-term, moderate to major effect from the facility from KOP 6. There would be a moderate change to the landscape compared to Alternative M1, which would not meet VRM Class II. However, KOP 6 is the only point along Thompson Creek Road from which a major feature of the mine can be seen, and the view from the KOP is exceptionally close to the mine.

4.11.1.3. Alternative M3 – No Name Waste Rock Storage Facility

The effects from the KOPs from the Buckskin and Pat Hughes WRSFs would be essentially the same as under Alternative M2, except for the development of the No Name WRSF on BLM land. Approximately half of the BLM land is designated VRM Class II and the other half is designated VRM Class III. Of the KOPs, only the view from KOP 2 would be affected (Photo 4.11-9., Photo 4.11-10., both before reclamation).

The No Name WRSF would be visible for a short distance, approximately a few hundred feet, for travelers going east or west on Thompson Creek Road. The facility would be upslope, 0.3 mile from KOP 2 and would introduce a new landform that would be the shape of an inverted pyramid. The waste rock would be mottled shades of tan, light brown, with grays and some yellow to white. The medium-textured waste rock would distinctly contrast with the relatively coarsely textured surrounding vegetation. The facility would block the view of (and cover) the rock outcrops near the horizon in the background, simplifying the landscape. Simplification of the landscape removes dynamic interest and focuses the attention of the viewer on the unnatural facility. The facility would distinctly attract the viewer's attention, particularly if active rock placement in the facility were visible from the KOP.

Photo 4.11-9. View from KOP 2, Alternative M1.

Photo 4.11-10. View from KOP 2, simulation for Alternative M3.

In the short term, while the facility would be developed, no or very little activity would be visible and there would be no or negligible effects from KOP 2. After mining there would be a long-term, major effect as the facility would be a major change to the landscape with an obviously human-made feature in distinct contrast with the surrounding land form, color, and texture. The VRM Class II designation would not be met. However, after reclamation (e.g., planting additional trees in the open spaces around the KOP to partially block or break up the view) the facility would not dominate the view.

4.11.2. Mine Lighting and Dark Night Skies (MMPO Alternatives)

Under Alternative M1 the levels of nighttime equipment operation and lighting would continue to affect dark night skies until approximately 2016. Subsequent reclamation would reduce the effects (illuminated mining activities) to dark night skies. After completion of core reclamation (~ 2020) there would be few or no remaining lights and little or no residual effects to dark night skies. Under Alternative M2 there would be essentially the same effects to dark night skies as under Alternative M1, both before and after reclamation, except the effects would continue until approximately 2030 instead of approximately 2020 (the end of core reclamation) (short-term, minor effect). Under Alternative M3 there would be vehicle lights visible from a new area of the mine at night, but overall effects to dark night skies would be similar to those under Alternative M1 and Alternative M2.

4.11.3. Land Disposal Alternatives

4.11.3.1. Alternative L1 – No Action

There would probably be no major changes to the visual resources of the selected land or offered lands in the short term. However, in the long term the offered lands may have new (Garden Creek property) or additional development (Broken Wing Ranch) with unknown effects to visual resources. As private land, the offered lands have no VQO or VRM designations.

4.11.3.2. Alternative L2 – Land Exchange Proposal

There would be no effects to the visual resources of the selected land other than those resulting from the mine (Section 4.11.1). There would be no effects to the visual resources of the Garden Creek property. Sensitive viewers of the ranch would be travelers on SH 75 and nearby residents. Viewers who frequently travel SH 75 and nearby residents would be more sensitive to the visible changes in land use. No distinct changes to visual resources would occur in areas that would continue in agriculture (BWR-2 and BWR-5, and portions of BWR-4 and BWR-6). However, people familiar with the ranch may notice fewer cattle along the riparian corridors, and there would be increased numbers of people and vehicles at the ranch, particularly driving through the ranch to access the Lyon Creek drainage or sections of the Salmon River. Groups of people may attract the attention of viewers in the area, as well as camping trailers and gear, such as tents which are frequently brightly colored in contrast to the natural surroundings (long-term, minor effect).

Subparcel BWR-1 would have more riparian vegetation (long-term, minor effect) due to a less pastoral or agricultural setting and vegetation that appears more natural (due to reduced grazing). There would probably not be any meaningful effects from the two private parcels which already have buildings and are occupied by people and vehicles. Facilities such as kiosks and restrooms

(e.g., interpretive sites on BWR-6 or a developed recreational facility on BWR-4) would be designed to blend with the natural surroundings, individually the lines and form of the facilities would be a minor, long-term change in the landscape. There would probably be long-term, moderate effects from developing a campground, e.g., concentrated human activity, lights visible at night including from campfires. However, the effects to dark night skies would be localized and minimal. People using the Challis East Subdivision Trail would at times attract the attention of people on the adjacent properties, particularly if motorized use was allowed or flashlights or headlights were used at night (long-term, minor effect).

Under Alternative L2-B, in the short term, there would be no cattle at the ranch but agricultural activity (e.g., tractors and irrigation) would continue and the fields would change from cultivated fields (brown when plowed, green during the growing season, and yellow during the non-growing season) to brown fields with sparse sagebrush and grasses (major effect). In the long term the fields would gradually change to yellow brown sagebrush steppe (sagebrush grasslands), there would be no cattle, and the irrigation equipment would be removed (long-term, major effect).

4.11.3.3. Alternative L3 – Land Sale

There would be the same effects as under Alternative L1.

4.11.3.4. Alternative L4 – Reduced Area Land Exchange, Fee Simple

There would be the same effects to approximately 3,600 acres of selected land as for Alternative L1. The effects to the offered lands would be the same as for Alternative L2 for the portions of the ranch and Garden Creek property acquired by the US, and the same as under Alternative L1 for those portions of the ranch or the Garden Creek property not acquired by the US.

4.11.3.5. Alternative L5 – Reduced Area Land Exchange, Easement

The effects to the selected and offered lands would be the same as those described for Alternative L4. Note that although the easement would protect approximately 1,500 acres of selected land from most potential effects to visual resources, the potential effects after post-mining if the easement were not in place are not reasonably foreseeable.

4.12. Land Use and Recreation

4.12.1. MMPO Alternatives

4.12.1.1. Alternative M1 – No Action

Multiple-use (primarily mining, grazing, and limited dispersed recreation) would continue as it has in the past and would be consistent with BLM and Forest Service land management plans. There would be no change in land jurisdictions. There would be no change to the BLM RMS classification of Middle Country for the MMPO because the existing operational area is also in the Middle Country classification. The NFS land in the MMPO would remain under the Rural ROS classification. There would not be any recreational access points, recreation areas, access roads, or trails closed due to the mine. There would not be any development or encroachment

into the S. Creek IRA. Users of this IRA would not experience any different conditions from those currently experienced due to the mine. There would not be any effects to SMAs.

The current recreational opportunities and land use would continue until mining ceases (~ 2016) and late-stage reclamation was completed (~ 2025). Land management plans have changed since the 1980 FEIS (USFS 1980), but the overall management principles have remained similar and would remain similar in the foreseeable future.

4.12.1.2. Alternative M2 – MMPO as Submitted by TCMC

Land Jurisdiction

There would be no change in land jurisdictions.

Land Use

Mining would continue with 497 acres changing from generally undeveloped forest to land disturbed by the mine. The change would affect only 0.01 percent of the land in Custer County, but would affect all of the MMPO area (long-term, major effect). The TCMC ROWs involving only the selected land would be relinquished (e.g., the exclusive easements for the Bruno Creek, Pat Hughes, and Buckskin roads). The TCMC ROWs involving some but not all of the selected land (e.g., the Cherry Creek road) would be modified to exclude those portions.

Special Management Areas

A total of 200.1 acres (0.03 %) of the Challis ERMA would be developed with mine facilities (negligible effect). There would be no effects to SMAs, and no disturbance in the S. Creek IRA. Users of this IRA would not experience any different conditions compared to under Alternative M1.

Recreation

There would not be recreational opportunities on 200.1 acres of BLM land and 185.5 acres of NFS land. The remainder of the analysis area (110.0 acres) is TCMC land for which recreational access would not change, e.g., TCMC employees would not be allowed to recreate on this land. There would be no change to the BLM RMS classification of Middle Country for the MMPO because the current mine operations are in the Middle Country classification. The NFS land in the MMPO area would continue to be classified as Rural ROS. There would not be any recreational access points, recreation areas, access roads, or trails closed due to the mine. However, the analysis area would not offer high quality recreation opportunities due to its proximity to the mine, and the decreased area available for recreation would be relatively small (negligible effects).

4.12.1.3. Alternative M3 – No Name Waste Rock Storage Facility

Land Jurisdiction

There would be no change to land jurisdictions.

Land Use

The effects would be similar to those under Alternative M2, but less of the Pat Hughes Creek drainage and no additional Buckskin Creek drainage would be disturbed. The No Name Creek drainage would change from undeveloped and forested to a WRSF (47 % more land converted than under Alternative M2) (long-term, major effect).

Special Management Areas

A total of 417.9 acres (0.06 %) of the Challis ERMA would be developed with mine facilities compared to 200.1 acres (0.03 %) of the ERMA for Alternative M2 (negligible effect).

Recreation

Over twice as much recreational access would be lost on BLM land than under Alternative M2, but such effects would still be negligible.

4.12.2. Land Disposal Alternatives

4.12.2.1. Alternative L1 – No Action

There would be no decrease in Federal land in the BLM Challis Field Office area, or increase in Federal land in the BLM Pocatello Field Office area. The selected land would remain forested land around a large mine administered the BLM. The BLM does not have plans to harvest timber or develop any new recreation facilities (e.g., trails or campgrounds) at the selected land. One commercial outfitter would continue to hunt on the selected land under a BLM special recreation permit. The BLM ranch management strategies would not be implemented. Development at the Garden Creek property and additional development at the ranch would probably occur in the foreseeable future. In particular, there would be a moderate probability that portions of the ranch frontage along 4.4 miles of the Salmon River and 0.9 miles of Lyon Creek would be sold in the foreseeable future for development/recreational use. Federal land would not be consolidated in the localities of the ranch or the Garden Creek property.

4.12.2.2. Alternative L2 – Land Exchange Proposal

Land Jurisdiction

The selected land (~ 5,100 acres) would become privately owned, and the offered lands (813 acres less 5 acres donated to Custer County by TCMC) in the BLM Challis Field Office area would be transferred to the US under BLM administration – a net decrease of approximately 4,300 acres of Federal land in the BLM Challis Field Office area. In Custer County there would be a negligible decrease in Federal land (93.2 to 93.0 %), a negligible increase in private land (5.0 to 5.2 %), and a negligible increase in county land (0.0730 % to 0.0731 %). In the BLM Pocatello Field Office area there would be an increase of 82 acres of Federal land in Bannock County (negligible effect).

Land Use

Most of the selected land (96 %) would remain forested and undeveloped (negligible effect). The BLM special recreation permit for one commercial outfitter would be modified to exclude the selected land. However, the outfitter would have access to commercially guide on the areas of the selected land currently used for hunting under the Access Yes program (with motorized access to Thompson Creek Road), and the State of Idaho no longer requires outfitters to be licensed to operate on private property (long-term negligible to minor effect).

The Broken Wing Ranch would be managed according to the BLM ranch management strategies under Alternative L2 or Alternative L2-B. The two parcels that would be donated to Custer County would be used for the benefit of the county such as educational purposes (e.g., partnership with an institution such as Boise State University for a geologic summer field camp), county business, or sold to raise revenue for the county (long-term, moderate effects). Acquisition of the ranch by the US would allow the BLM to create cooperation and partnerships to reconnect large landscapes to enhance water quality and protect fish and wildlife habitat by implementing standards and management practices that would complement the surrounding BLM lands. The ranch would not be further subdivided and developed along the Salmon River or Lyon Creek (e.g., Photo 4.12-1., Photo 4.12-2) (long-term, moderate effect). The use of the ranch by the public would slightly increase the probability of wildfire at the ranch (negligible effect).

Photo 4.12-1. New residential development along the Salmon River.
Land formerly part of the Broken Wing Ranch, October 2008, view to east.

Photo 4.12-2. Gravel pit.
Land formerly part of the Broken Wing Ranch, November 2012, view to southwest.

The non-irrigated, unfenced areas (~ 360 acres)[7] of the ranch are currently grazed by cattle from the BLM Bald Mountain and Split Hoof grazing allotments. These unfenced areas of the ranch would be incorporated[8] into the Bald Mountain Allotment to the east (an increase of ~ 275 acres or 1.7 % and an increase of ~ 7 AUMs or 1.6 %), and the Split Hoof Allotment to the west (an increase of ~ 90 acres or 1.1 % and an increase of ~ 2 AUMs or 1.1 %)[9] (long-term, minor effect).

Overall there would be a long-term, moderate effect to land use on the ranch, but a negligible effect on agricultural land use as a whole in Custer County. Under Alternative L2-B there would be a long-term, major effect on land use (i.e., conversion of the ranch to native vegetation and no livestock grazing). Under either ranch management strategy the three pivots would be allowed to irrigate their full perimeters, i.e., a few acres of BLM land adjacent to the ranch would be irrigated (the areas are not currently irrigated). The Garden Creek property would probably be

[7] 813 acres on ranch subparcels; 424 acres cultivated; 389 acres rangeland - 20 acres disturbed - 6.8 acres riparian shrubland = 362 acres rangeland

[8] by land use plan maintenance extending the existing BLM administration of the adjacent BLM land (allotments) to the relevant portions of the acquired land (ranch) as opposed to a land use plan amendment

[9] assume equal surface disturbance and riparian shrubland (13.4 acres) on rangeland on ranch adjacent to Bald Mountain and Split Hoof allotments; Bald Mountain allotment = 388.99 acres -13.4 acres - 102.42 acres for Split Hoof allotment = 273.2 acres; 273.2 acres / 37.2 acres/AUM = 7.3 AUMs; Split Hoof = 89.1 acres / 45.6 acres/AUM = 2.0 AUMs

administratively incorporated into the Old Tom Allotment, for an increase of 15 percent in the available AUMs for the allotment (long-term, moderate effect).

Special Management Areas

There would be a decrease of approximately 4,300 acres (0.7 %) of Federal land in the Challis ERMA (negligible effect). There would be an increase of 813 acres (1.9 %) of Federal land in the Upper Salmon River SRMA, which would help the BLM meet the objectives of the SRMA, e.g., protecting and enhancing recreational opportunities in the BLM Challis Field Office area. The BLM has recommended recreation improvements on the ranch that would increase access to the Salmon River and enhance camping opportunities in the BLM Challis Field Office area (Table 2.2.1.) (negligible effect). Although the portion of the river that runs through the ranch is not designated Wild and Scenic, there would be improved recreational access to portions of the river that are eligible for Wild and Scenic designation/recreational classification (long-term, minor to moderate effect). Such change in access and the quality of recreation would be noticeable to most individuals currently recreating in the area (long-term, moderate effect). Although the Challis Wild Horse and Burro HMA is adjacent to the ranch, there would be no effects to the HMA except for the inclusion of the portions of BWR-5 into the HMA (i.e., all BLM land east of SH 75) (negligible effect). There would be an increase of 82 acres (0.01 %) of Federal land in the Pocatello ERMA (negligible effect).

Recreation

There would not be any trails, campgrounds, or other developed recreation sites at the selected land, and TCMC does not propose any such improvements. TCMC would pursue a donated Access Yes agreement through the IDFG to allow hunter/angler access with the exception of the selected land that drains into Bruno Creek, Buckskin Creek, Pat Hughes Creek, and Cherry Creek (Figure 2.2-8.) (negligible effects, especially considering the scarce public use of the selected land in the past). The existing public access along the upper Thompson Creek Road would be retained by the BLM. The public would continue to be able access the Upper Thompson Creek Road by the Forest Service Road #040 ("North Slate Creek Bridge Road"); the Forest Service has an easement from TCMC for public access for the portion of the road which passes through TCMC property (no effect).

Portions of the Broken Wing Ranch could be developed with recreational facilities (Section 2.2.2.) improving the recreational opportunities in Custer County. The ranch would be under the BLM RSM classification of Rural: land within ½ mile of paved or primary roads with a landscape that has been considerably modified by agriculture, residential, or industrial uses. The classification includes facilities such as boat launches and campgrounds, and sounds of people can frequently be heard. Such change in access and the quality of recreation would be noticeable to most individuals currently recreating in the area (long-term, moderate effects). Under Alternative L2-B there would be the same fence array, but people would have year-round use of the converted area and there would not be people-cattle conflicts, or cattle manure (long-term, minor effect).

There are no specific management objectives planned by the BLM for the Garden Creek property, but the parcel would be open to non-motorized public recreation, including hiking, camping, and hunting. The BLM does not apply RSM classifications in the Pocatello Field

Office, so there would not be a RSM classification for the Garden Creek property. Acquiring the Garden Creek property would consolidate Federal land jurisdiction around the Garden Creek property, and make it easier for the public to recreate by not having to keep track of property lines (long-term, minor effect).

4.12.2.3. Alternative L3 – Land Sale

Land Jurisdiction

There would be a decrease of approximately 5,100 acres of BLM land in the Challis Field Office area, which would result in a small decrease in the Federal land in Custer County (93.2 % to 93.0 %), and a small increase in the private lands in the county (5.03 % to 5.19 %) (long-term, minor effects). The BLM would no longer administer approximately 500 mining claims, two ROWs, and portions of several easements associated with the selected land.

Land Use

There would be the same effects related to the selected land as under Alternative M2. There would be the same effects related to the offered lands as under Alternative L1.

Special Management Areas

There would be essentially the same effects to SMAs as under Alternative L2.

Recreation

The recreation opportunities on the selected land would be the same as under Alternative L2.

4.12.2.4. Alternative L4 – Reduced Area Land Exchange, Fee Simple

Land Jurisdiction

Compared to Alternative L1 there would be a decrease of BLM land in the Challis Field Office area: approximately 3,600 acres less approximately 550 acres of the Broken Wing Ranch that would be acquired by the US. Such would result in a small decrease in the Federal land in Custer County (93.2 % to 93.1 %), and a small increase in the private lands in the county (5.03 % to 5.05 %) (long-term, minor effects). The effects related to the Garden Creek property would be negligible, regardless of whether the property was acquired by the US or not.

Land Use

The selected land would be managed the same as under Alternative L2, except the S. Creek Road easement would be for only a short length of the road and much of the area that could be accessed by the public would be accessible as Federal land and not private land under the Access Yes Program. Compared to Alternative L1 the land uses would not change for all of the ranch subparcels and/or the Garden Creek property that would be eliminated from the land exchange.

Special Management Areas

The area of Federal land in the Challis ERMA would decrease by approximately 3,050 acres (3,600 acres less 550 acres), or 0.4 percent (negligible effect) compared to Alternative L1. Depending on how much of the ranch would be removed from the exchange, there would be an

increase of up to 813 acres of Federal land in the Upper Salmon River SRMA (negligible effect). Unless the Garden Creek property was removed from the exchange, there would be an increase of 82 acres (0.01 %) of Federal land in the Pocatello ERMA (negligible effect).

Recreation

Recreation opportunities on the selected land would be the same under Alternative L2, except the public could access approximately 1,500 acres of the land as Federal land instead of accessing the area as private land under the Access Yes Program. If ranch subparcels were eliminated from the exchange, the acquisition of the ranch by the US would not meet the goals of the Upper Salmon River SRMA as well as under Alternative L2.

4.12.2.5. Alternative L5 – Reduced Area Land Exchange, Easement

For properties for which most of the fair market value is due to development potential (river frontage, scenic mountain views, beach frontage, etc.), conservation easements are worth as much as 85 percent of the fair market value of the property. However, a conservation easement on an isolated tract of 1,500 acres of rugged terrain adjacent to the mine with little potential for development (i.e., the easement area of Alternative L5) would be worth approximately 25 to 50 percent of the fair market value of the tract without such easement. Therefore, the fair market value of the selected land would be reduced by approximately 10 percent compared to under Alternative L2. The US would thus acquire approximately 10 percent less by fair market value of the offered lands.

Land Jurisdiction

There would be approximately 10 percent less (by fair market value) of the offered lands acquired by the US as compared to Alternative L2 (long-term, moderate effect).

Land Use

The effects on land use would be similar to under Alternative L2, except approximately 1,500 acres of the selected land would be protected by a conservation easement. Such would allow approximately 10 percent more of the offered lands to be acquired than under Alternative L2 (long-term, moderate effect). Therefore, more of the land uses associated with the BLM ranch management strategies would be implemented (long-term, minor effect). In addition, the BLM would have to administer the easement (see Section 4.13.2.5. for the economic effects).

Special Management Areas

The effects on SMAs would be similar to those under Alternative L2, except there would be slightly more land than under Alternative L4 to help to meet the goals of the Upper Salmon River SRMA.

Recreation

The effects on recreation would be similar to under Alternative L2, except there would be a guarantee of no future disturbance of the selected land via a conservation easement. There would be slightly more land than under Alternative L4 for implementation of the BLM ranch management strategies.

4.13. Socioeconomic Factors

4.13.1. MMPO Alternatives

The baseline economic influence of the mine in Custer County are 1) the TCMC employees living in Custer County, 2) TCMC purchases of goods and services from vendors in the county, and 3) spending by TCMC employees and by employees who work for county vendors. These values were estimated using RIMS II and divided into *direct*, *indirect,* and *induced* economic effects. *Direct* effects are the changes in sales, employment and labor earnings that occur during the first round of spending in the affected industry (i.e., the mine). *Indirect* effects are the changes in sales, employment, and labor earnings in a region in backward-linked industries that supply goods and services to the affected industry. *Induced* effects are changes in sales, employment, and labor earnings in the region resulting from household spending of the income earned in the affected industry and in the supporting industries. Note that essentially all of these direct, indirect, and induced economic effects are *indirect NEPA effects* occurring as a result of activities on private land. Note also that the effects are described for the steady production typical of mine plans, but the effects would probably be somewhat cyclical due to the cyclical price of molybdenum in the world market, e.g., TCMC revised its mining schedule in October 2012 to temporarily delay Phase 8 overburden removal and reduce its workforce from 379 to 274 (TCMC 2012a).

4.13.1.1. Alternative M1 – No Action

TCMC would cease mining in approximately 2016. The annual economic effects of the mine that would not occur after 2016 would be a combined direct, indirect, induced, and secondary employment in Custer County and Idaho, respectively, of 935 jobs and $49.0 million in earnings, and 1,665 jobs and $88.2 million in earnings.

After mining, the annual economic effects during core reclamation would be a combined direct, indirect and induced, and secondary employment in Custer County and Idaho, respectively, of 515 jobs and $27.0 million in earnings, and 830 jobs and $44.1 million in earnings. The annual economic effects during late-stage reclamation would be 45 jobs and $2.5 million in earnings in Custer County and 75 jobs and $4.0 million in earnings in Idaho. The annual effects during long-term reclamation would be 10 jobs and $0.6 million in earnings in Custer County and 20 jobs and $1.0 million in earnings Idaho. There would be no change in BLM grazing revenue, grazing administration costs, or other BLM administrative costs.

Idaho receives approximately $2.5 million each year in personal income tax related to the $88.2 million in earnings from the TCMC mine in Idaho. More specifically, Custer County received $807,921 in property taxes in 2010 from TCMC, as well as substantial amounts of property taxes paid by TCMC employees. Most of these employees would not likely stay in the area after their employment ended at the mine; therefore, most (> 75 %) of these employees would move from the county after core reclamation is completed (Gardner 2012b). The housing market, particularly in Challis, would experience an increase in properties for sale and a decrease in fair market value. The relatively few employment options in the county would decrease substantially at the end mining (~ 180 less jobs) and core reclamation (~ 380 less jobs).

In addition, there would be proportional decreases in population and funding for public schools, and increases in utility costs and property taxes for the remaining county residents. The decrease in population would be concentrated in the Challis locality and would substantially reduce the number of school age children. Schools would accordingly receive less funding from Idaho, with probable increases in student to teacher ratios.

The reduced electricity consumption from the mine closure would have little effect on electricity bills because of the pass-through arrangement among TCMC, SREC, and the Bonneville Power Administration (Diaz 2010). However, the costs of the electricity distribution infrastructure would be divided among fewer SREC members, e.g., an increase in the basic service charge ($30 for most people in 2012) of 25 percent.

There would also be the loss of substantial community support by TCMC and its employees. For example, TCMC has five employees that are fire fighters with the Challis Volunteer Fire Department and six employees that are emergency medical technicians with the Challis Volunteer Ambulance Service. TCMC employees are also involved in partnerships with 18 organizations ranging from the Hospital Board to the 4-H program, and TCMC typically provides more than $100,000 each year to a group of approximately 75 organizations such as the Challis High School, Challis Public Library, Lemhi-Custer Cancer Relief Fund, and Butte County Extension Office (Natoli 2014).

TCMC pays approximately half of all property taxes in the county. In addition, property taxes on residential property, much of which is owned by TCMC employees, were 42 percent of all property taxes paid in 2009 to the county. Mining activities, dominated by TCMC, accounted for 37.5 percent of the tax revenue in the county. The loss of such a large taxpayer would result in a higher tax levy assessment on all real and personal property in the county, particularly for residential property owners in northern Custer County. If the entire tax burden could not be shifted, property tax revenue would decrease with less money to local units of government, school districts, police, fire, ambulance, health, libraries, etc. These entities would have to reduce staff and/or services. All of the ROWs required for the mine are authorized by the current MPO. However, TCMC chooses to also maintain some of these ROWs under the FLPMA, and annually pays the BLM approximately $3,600 in fees for these ROWs.

The mine would produce approximately 80 million pounds of molybdenum during 2012 to 2016. The mine currently (2011) produces approximately 5 percent of the world molybdenum production and approximately 15 to 20 percent of US molybdenum production. Should such molybdenum production permanently cease (e.g., final reclamation under Alternative M1), there would be an immediate increase in the worldwide price of approximately 20 percent, gradually declining over several years with demand destruction and as other producers slowly replaced the supply (Gardner 2012a). The closure of the mine under Alternative M1 would also cause a decrease of 15 to 20 percent in US molybdenum exports, affecting the annual US current account balance (i.e., trade deficit) by a few $100 million.

4.13.1.2. Alternative M2 – MMPO as Submitted by TCMC

The socioeconomic effects would be the same as for Alternative M1, except the BLM would lose the potential to collect minimal revenue (e.g., $2.70 at the 2012 rate) in grazing fees due to the decrease of 2 AUMs for the Thompson Creek Allotment (if the allotment were grazed in the future); grazing administration costs would be the same as for Alternative M1. The mine would also produce an additional 126 million pounds of molybdenum under Alternative M2 compared to Alternative M1, and would not affect US molybdenum exports or affect the US trade deficit until 2026. The socioeconomic effects of the mine would continue (or in some cases be delayed) under Alternative M2 for an additional 9 years compared to Alternative M1 (long-term, major effects). TCMC would probably sell a few truckloads per year (~ 4,000 board feet/truckload) of the timber harvested from the mine (Section 4.4.1.2.) to small, local mills but most of the timber would probably be donated for use as community firewood (short-term, minor effect). In addition, TCMC would save $1,000,000s of dollars by reclaiming the surface of the Buckskin WRSF with less soil cover than for Alternative M1 (Section 2.1.1.8.) (temporary, major effect to TCMC; temporary minor to moderate effect to the vendors which would not receive such business).

4.13.1.3. Alternative M3 – No Name Waste Rock Storage Facility

The socioeconomic effects would be the same as for Alternative M2, except TCMC would incur substantial additional costs (e.g., greater than $10 million) to develop, use and reclaim a new WRSF in a previously undisturbed drainage with a longer haul distance than that of the existing Buckskin and Pat Hughes WRSFs. The development would require new roads, pipelines, a sedimentation pond, an underdrain, diversion ditches, etc. This would be a short-term, major effect to TCMC, and a long-term, moderate effect to Custer County (due to additional vendor income from equipment, materials and services purchased locally by TCMC). Conversely, there would be an increase in incomes and revenues in the analysis area due to an increased need for goods and services to construct the additional waste rock facility that would be greater than that under Alternative M2 (short-term, moderate effect).

4.13.2. Land Disposal Alternatives

4.13.2.1. Alternative L1 – No Action

Custer County would continue to receive approximately $2,000 each year in property taxes for the Broken Wing Ranch. However, a small subdivision of the ranch with residential development along the Salmon River corridor could reasonably be developed in the foreseeable future. Such a subdivision would increase the overall assessed property value of the county, e.g., six river-front homes each on 5 acres with an assessed value of ~ $300,000 would each generate ~ $1,000 in annual property taxes (Custer County 2014). Bannock County would continue to receive $100 each year in property taxes for the Garden Creek property (Hymas 2010). If the Garden Creek property were subdivided in the future and developed into residential property, Bannock County would receive increased property tax revenue from the property.

There would be no change in the property values of lands adjacent to the selected and offered lands due to changes in jurisdiction of the selected and offered lands, e.g., private lands near scenic Federal lands typically have higher fair market value than comparable private lands

located elsewhere (the proximate principle). There also would be no change in BLM grazing revenue, grazing administration costs, or other BLM administrative costs. Also, none of the effects of the BLM gaining title to the offered lands would occur.

4.13.2.2. Alternative L2 – Land Exchange Proposal

Acquisition of the Broken Wing Ranch by the US would result in Custer County not receiving $2,000 to approximately $8,000 in annual property taxes for the property. Transfer of the selected land from the US to TCMC would result in the county receiving approximately $240 to $25,000[10] in annual property taxes for the land (negligible effects). The change in jurisdiction (Federal to private) of the selected land could cause a slight reduction (< 3 %) in the value of private land adjacent or near to the selected land (e.g., the Redbird property). However, there would be no new mining operations (under any of the MMPO alternatives) near any private land; the mine has been operating for more than 30 years; and there would be little change to the public access of the selected land (Section 4.12.2) (long-term, minor effect). If Custer County were to sell the two donated parcels on the ranch, the county would receive a few $100,000s (and ~ $1,800 in annual property taxes). The BLM (non-standard) administrative costs for the ranch would be approximately $8,000 the first year and $1,500 for each subsequent year, plus approximately $5,000 to $10,000 to install interpretive kiosks/signs (negligible effects). If the ranch were leased, the BLM would probably receive a few $1,000s per year for the fair market value of the lease (negligible effect) (Gardner 2013a).

The change in jurisdiction (private to Federal) of the offered lands may cause a slight increase in the value of private lands near the Broken Wing Ranch, e.g., the ranch would not be subdivided for residential development along the Salmon River (long-term, minor effect to property values). There would be no such effect related to the Garden Creek property because there is no private land near the property. The PILT payments to Custer County would not change if the county was to gain additional Federal acres due to the population cap, as the county would have to lose more than 800,000 qualified Federal acres before PILT payments would be reduced. The transfer of the Garden Creek property to the US would result in the annual decrease of $100 (bare land) or as much as $20,000 (developed land) of future property taxes for Bannock County (negligible effect).

The counties would not receive any construction revenue from the potential development of the offered lands (negligible effect). However, the ranch would continue to raise approximately 300 AUMs of cattle each year providing farm income (long-term, minor effect), and annual grazing fees to the BLM of $405 (300 AUMs x $1.35/AUM, negligible effect). In addition, the ranch could provide new recreational and educational opportunities, including a revenue-generating facility for the Idaho Parks and Recreation Department (long-term, minor effect).

The BLM (Washington Office via non-appropriated funds) would no longer receive approximately $60,000 each year from TCMC to maintain mining claims on the selected land (negligible effect) (Gardner 2012a). The BLM would also probably stop receiving annual fees of approximately $3,600 from TCMC for ROWs on the selected land (negligible effect). However,

[10] The property taxes would be calculated as a base rate (depending on the appraisal category and appraisal factor) multiplied by the acres subject to the base rate multiplied by the levy rate. The appraisal categories and appraisal factors would depend on how TCMC uses the portion of the land not covered by an MPO.

the BLM would save of the order of $10,000 each year in administrative costs related to the MMPO (long-term, minor effect). If the BLM would no longer administer the MPO for the mine (Section 1.4.), TCMC would save of the order of $10,000 each year in administrative costs by reducing the redundancy of three land management agencies to two land management agencies (long-term, minor effect).

Under Alternative L2 the BLM would have the same grazing administration costs for the S. Creek and Thompson Creek allotments, and would collect the same grazing revenue for the S. Creek Allotment as under Alternative L1. However, the BLM would not collect annual grazing fees for 41 AUMS in the Thompson Creek Allotment should the allotment be grazed in the future (41 AUMs x $1.35/AUM = $55.35, negligible effect). Given the few remaining AUMs in the allotment and the resource concerns along the Thompson Creek riparian area where most grazing in the allotment has typically occurred, the BLM would probably consider amending the Challis RMP to make the Thompson Creek Allotment unavailable for livestock grazing. In this case, the BLM would decrease its grazing administration costs (due primarily to NEPA analysis and associated litigation) of the order of $10,000 each year (long-term, minor effect).

Under Alternative L2-B the cultural character of the ranch would change completely, i.e., operating agricultural/cattle ranch since the early 1900s to vacant (except for the fences and the one or two parcels donated to Custer County or the parcel sold by TCMC) sagebrush grasslands (long-term, moderate effect). There would be a reduction of 1 of the 261 farms (0.4 %) in Custer County (Table 3.13-12.), and the elimination of perhaps the most scenic ranch in the county (long-term, minor effect). The BLM Challis Field Office would need to reimburse the Bonneville Power Administration $150,000 for the conservation improvements tied to the conservation easement for the ranch (WSLM 2012), (one-time, major effect to the field office budget). The BLM Challis Field Office would also need to maintain the fences at average costs per year of approximately $500 (~ 2 days of maintenance) and $6,000 (fence replacement; recent fence construction on the ranch of $57,000/11,790 feet ≈ $5/foot; fence on ranch ≈ 49,000 feet; 40 year fence life) (long-term, negligible or minor effect). In addition, the BLM would not receive grazing fees (2,390 AUMs/year x $1.35 = $3,200/year) or a lease fee (few $1,000s) for the ranch (long-term, minor effect).

Under Alternative L2-B the BLM cost to convert the ranch to native vegetation would be approximately $215,000 the first year, and $110,000 for the second and third years, with $150,000 earned from salvage of the irrigation equipment (Gardner and Redick 2013) (short-term, major effects to the field office budget), with a (non-standard) weed eradication cost of approximately $2,000 per year for 5 to 10 years (negligible effect). The BLM would not have the (non-standard) costs to administer the ranch, and would not receive a few $1,000s in grazing or lease fees (negligible effects). The ranch operator would lose $60,000 in annual revenue from hay production (150 tons/cutting x 2 cuttings x $200/ton) as well as approximately 2,400 AUMs of forage. To compensate for the loss of forage, the operator would need to each year 1) pay private grazing fees of $35,000 ($14.50/AUM) (if so many private AUMs were available in the region), 2) purchase hay for $187,000 ($77/AUM), or 3) reduce the cattle herd with a loss in revenue of $249,000 ($102.50/AUM) (long-term, major effects) (Section 3.13.2.1).

4.13.2.3. Alternative L3 – Land Sale

The effects would be the same as for Alternative L1, except the US Treasury would have a one-time gain of several million dollars (negligible effect), Custer County would receive approximately $240 to $25,000 in annual property taxes for the selected land (negligible effect), and the effects of the US acquiring the offered lands as outlined under Alternative L2 would not occur. In addition, if the land was sold to a party other than TCMC, the company would probably incur $10,000s to $100,000s per year in costs from operating on private property not owned by TCMC (long-term, major effect).

4.13.2.4. Alternative L4 – Reduced Area Land Exchange, Fee Simple

The effects would be similar to under Alternative L2, except Custer County would receive approximately $170 to $17,000 in annual property taxes for the smaller amount (reduced by ~ 1,500 acres) of selected land compared to approximately $240 to $25,000 under Alternative L2 (or no additional property taxes under Alternative L1). In addition, the county would receive approximately $600 (30 % of $2,000) instead of $0 under Alternative L2 ($2,000 under Alternative L1) in annual property taxes for a small area of the Broken Wing Ranch that would not be acquired by the US; the US would probably acquire all of the ranch with high development (tax revenue) potential. It is also possible that less or none of the Garden Creek property would be acquired by the US. Regardless, all of the effects would be negligible.

4.13.2.5. Alternative L5 – Reduced Area Land Exchange, Easement

The effects would be similar to those of Alternative L4, except Custer County would receive as much as $170 more in annual property taxes due to the approximately 1,500 acres of selected land under the conservation easement. In addition, the county would receive approximately $200 (10 % of $2,000) instead of approximately $600 under Alternative L4 (because there would be an even smaller area of the ranch than under Alternative L4 that would not be acquired by the US). It is also possible that less of the Garden Creek property would be acquired by the US (negligible effects). In addition, the BLM would have to administer the easement for the 1,500 acres (~ 6 hours/year staff time; $300/year) with the costs paid for by a trust fund established by TCMC (average annual investment return = 4 %, $7,500 principal), and a similar conservation easement (land disposal provisions, Section 2.2.7.) for Thompson Creek and S. Creek (minor effect to TCMC).

4.13.3. Non-market Environmental Monetary Value

In the case of the MMPO and land disposal alternatives there would be non-market monetary value for all resources – even things like land, easements, and water rights have non-market monetary value to those other than the seller and purchaser. Therefore, it is not feasible to identify the specific amounts that a myriad of people would theoretically pay for a myriad of abstract environmental values. However, given the relatively small areas, number of affected people, and magnitude of effects involved with these aspects of the project, the non-market value for each of the MMPO and land disposal alternatives is of the order of perhaps $1,000 or $10,000 per year primarily related to the value of private property adjacent to Federal lands and changes in public access. For example, people in Custer County have tremendous emotional value regarding access to land for recreation, but few people in the county would pay for the public access that would be gained or to avoid the loss of such under any of the alternatives.

4.13.4. Financial Guarantee

Under all of the MMPO alternatives (including Alternative M1), TCMC would fully reclaim the mine according to the approved reclamation plan. Regardless, the BLM, Forest Service, IDL, and IDWR would also continue to hold financial guarantees in the amount necessary to complete such reclamation using a third-party contractor, and would adjust the guarantees to conform to the reclamation plan that would be approved under the chosen MMPO action alternative. In particular, the BLM would require TCMC to establish a trust fund or other funding mechanism pursuant to 43 CFR 3809.552(c) to ensure the continuation of long-term water treatment to achieve State WQSs, NPDES effluent limitations, and for other long-term, post-mining maintenance requirements required by the reclamation plan (Section 1.9.21).

If the land exchange were completed, the IDL would obtain a financial guarantee comparable to that required by the BLM for the "earthworks" portion of the reclamation plan on BLM land, and the BLM would subsequently release the financial guarantee for such reclamation. However, the IDL may not have the authority to hold a financial guarantee for long-term water quality or other long-term, post-mining maintenance according to the reclamation plan. Consequently, any ROD approving a land disposal alternative would be conditional on TCMC establishing an irrevocable trust fund or other funding mechanism with the IDL for such long-term water treatment or other long-term requirements. The trust fund or funding mechanism would be identical or similar to that required by 43 CFR 3809.552(c) (Section 1.9.21). In such case, there would be essentially the same financial guarantee available to the IDL for the land disposal action alternatives as there would be available to the BLM for Alternative L1. The trust fund or funding mechanism would be identical or similar to that required by 43 CFR 3809.552(c) (Section 1.9.21). In such case, there would be essentially the same financial guarantee available to the IDL for the land disposal action alternatives as there would be available to the BLM for Alternative L1. For the land disposal action alternatives, if the BLM were no longer involved in administering the mine, only two (Forest Service and IDL) instead of three land management agencies for Alternative L1 would conduct inspections of the mine related to the MPO; a decrease of approximately four inspections per year.

4.14. Tribal Treaty Rights and Interests

4.14.1. MMPO Alternatives

The goal of the BLM Challis Field Office, the Forest Service, and the USACE regarding Tribal treaty rights and interests is to identify and consider Native American issues and concerns to accommodate treaty and other legal rights as well as other interests of appropriate Native American groups in the multiple-use management of Federal lands. Most of the effects to resources described in the other sections would affect Tribal treaty rights where those resources would occur on unoccupied Federal lands. Therefore, this section provides only a summary of those effects from the perspective of Tribal treaty rights, with a focus on unoccupied Federal lands.

4.14.1.1. Alternative M1 – No Action

The Federal lands in the BLM Challis Field Office area (793,081 acres) and SCNF (4,235,940 acres) are mostly undeveloped land, i.e., 98 to 99 percent of these lands would be unoccupied Federal lands available to exercise Tribal treaty rights (Gardner 2011b). There would not be any change to the amount of unoccupied Federal lands under Alternative M1. Both the Shoshone-Bannock and the Nez Perce tribes expressed concern over the stability of mine facilities such as the TSF and the pit lake during major seismic or flood events. Extensive and detailed site-specific geotechnical analyses demonstrate stability under both static and dynamic (i.e., during seismic shaking) conditions for the existing pit walls and the existing WRSFs and the TSF. The facilities would be stable during the maximum credible earthquake during both mining (temporary) and after reclamation (long-term). There would not be any effects to vegetation, forest resources, or weeds that would affect Tribal treaty rights, i.e., the mine operations that affect these resources would all be on occupied Federal lands.

The changes to water quantity and quality would effectively occur during two separate periods: mining and reclamation. The changes during mining that might affect Tribal treaty rights would include a very small reduction (1 %) in the flow of Thompson Creek due to installation of cutoff walls and sedimentation pond linings in the Buckskin Creek and Pat Hughes Creek drainages. After mining the changes to water quantity and quality that could affect Tribal treaty rights would include decreased water quality in S. Creek due to the acidification of the tailings embankment sands (late reclamation), including increased concentrations of sulfate, aluminum, arsenic, cadmium, cobalt, copper, iron, lead, manganese, nickel, uranium, and zinc under both best and upper estimates for low flow and the 7Q10 flow. With the exception of the concentration of cadmium for the 7Q10 flow/upper estimate, the concentrations of these constituents would meet the WQSs. Also, there would be the potential for decreased water quality due to problems in the long-term water management system. The water quality effects to S. Creek would be a long-term, moderate, adverse effect to Tribal use of S. Creek.

During periods of extremely low flow in S. Creek (on average once every 10 years) and for the predicted upper estimate (i.e., worst-case scenario), the concentration of cadmium would slightly exceed the WQS: 1.11 µg/L compared to the WQS $CCC_{cadmium}$ of 0.74 µg/L. The effects to fish in S. Creek for such exceedance cannot be accurately quantified, but would include at worst reduced survival of larval fish beyond baseline levels of larval mortality, or avoidance behavior that may limit feeding, migration, or predator avoidance. Accordingly, there could be a short-term decrease in juvenile recruitment for that year and a possible decline in fish population size to reduced adult fish health. However, cadmium does not readily bioaccumulate in fish (EPA 2011a). Any declines in fish population size for Chinook salmon, steelhead/rainbow trout, cutthroat trout, and sculpin would probably not reduce population viability in S. Creek as reproduction and recruitment in subsequent normal or higher-flow years would be unaffected (long-term, negligible to minor adverse effect on Tribal treaty rights associated with subsistence fishing).

4.14.1.2. Alternative M2 – MMPO as Submitted by TCMC

The expansion of the mine would increase the amount of occupied Federal lands in the BLM Challis Field Office area and SCNF, and reclamation would gradually return the mine site to unoccupied Federal lands of a condition where hunting, gathering, and other treaty rights could be exercised. There would be no known Tribal resources in the analysis area that would not be available in the remaining portions of the BLM Challis Field Office area or SCNF.

There would be an additional 386 acres of occupied Federal lands for the mine operations, less than 0.01 percent of the unoccupied Federal lands in the BLM Challis Field Office area and SCNF. The tribes would not be able to exercise treaty rights in this additional area of mine disturbance for the foreseeable future (long-term, minor, adverse effect on Tribal treaty rights). The extensive geotechnical analyses demonstrate that the pit walls, WRSFs, and TSF would be stable under both static and dynamic (i.e., during seismic shaking) conditions, including during the maximum credible earthquake during both mining and reclamation.

Certain plants are important for traditional Tribal uses including chokecherry, elderberry, current, red-twig dogwood (red willow), tulles, onions, turnips, all water plants (such as mint and watercress), huckleberry, gooseberry, raspberry, strawberry, sweet sage, carrots, bitterroot, camas, aspen, juniper, and lodgepole pine. Many of these plants would occur in the analysis area, but would not be available for Tribal use in the expanded mine area for the foreseeable future (long-term, minor, adverse effect on Tribal treaty rights). Despite weed management by TCMC, the additional 497.9 acres of disturbance at the mine would cause an increased threat of weed infestation at and near the mine (long-term, minor, adverse effect to Tribal use of vegetation).

There would be a very small decrease in flow in Thompson Creek (an additional 1 % compared to Alternative M1) due to increase disturbance and the cutoff walls. There would be an additional decrease in the water quality in Thompson Creek due to increased waste rock storage in the Buckskin Creek drainage and the Pat Hughes Creek drainage. The concentrations of copper, lead, and manganese would increase for the best estimate for both the low flow and the 7Q10 flow. The concentrations of aluminum, cadmium, cobalt, copper, iron, lead, manganese, uranium, and zinc would increase for the upper estimate for both low flow and the 7Q10 flow. However, with the exception of the concentration of copper for the 7Q10 flow/upper estimate, the concentrations of these constituents would meet the WQSs (long-term, moderate, adverse effect to Tribal use of Thompson Creek). There might be short-term declines in fish population size for bull trout, Chinook salmon, steelhead/rainbow trout, cutthroat trout, and sculpin, but there would not likely be a reduction in population viability in Thompson Creek as reproduction and recruitment in subsequent higher-flow years would be unaffected (negligible to minor adverse effect on Tribal treaty rights for subsistence fishing).

There would not be any effects to the availability or populations of game species that would affect Tribal hunting rights, except for a slight decrease in the amount of land available for Tribal hunting (long-term, minor, adverse effect to Tribal treaty rights for wildlife). Recreational access, including Tribal hunting access, would not be available on an additional 386 acres of Federal land used for mining (Table 2.1-5.), less than 0.01 percent of the land available to

practice Tribal treaty rights in the analysis area (long-term, minor, adverse effect). There would not be any effects to traditional cultural properties eligible for the NRHP. Site 10CR758 (eligible for the NRHP) would be partially inundated by the expansion of the TSF (long-term, adverse effect) (Section 4.21.6).

4.14.1.3. Alternative M3 – No Name Waste Rock Storage Facility

The effects to Tribal treaty rights would generally be the same as under Alternative M2. The exception would be 659 acres less unoccupied Federal land available to exercise Tribal treaty rights due to the construction of the No Name WRSF (long-term, minor, adverse effect).

4.14.2. Land Disposal Alternatives

4.14.2.1. Alternative L1 – No Action

There would be no affect to Tribal treaty rights, and no change in the amounts of unoccupied Federal lands in the BLM Challis Field Office area, SCNF, or Pocatello Field Office Area. There would be no change in the area available for Shoshone-Bannock Tribal preference use within the ceded boundary of Shoshone-Bannock Tribal trust resources (Fort Hall Indian Reservation). The 10 prehistoric cultural resource sites on the selected land would remain under Federal management. The four prehistoric cultural resource sites on the ranch would remain on privately owned land.

4.14.2.2. Alternative L2 – Land Exchange Proposal

Approximately 5,100 acres of BLM land (~ 4,450 acres unoccupied) would become private land owned by TCMC, and the US would acquire 813 acres of private land (Broken Wing Ranch) in the BLM Challis Field Office area. The ranch would become available for practicing Tribal treaty rights except for approximately 30 percent (~ 240 acres) of the ranch occupied with irrigated fields, roads, or structures. The result would be a net decrease of approximately 3,890 acres of unoccupied Federal land in the BLM Challis Field Office, approximately 0.5 percent of the unoccupied Federal land in the BLM Challis Field Office area (long-term, minor, adverse effect to Tribal treaty rights).

The acquisition of the Garden Creek property would increase the amount of unoccupied Federal land in the BLM Pocatello Field Office area by approximately 0.01 percent, and increase the amount of unoccupied Federal land within the ceded boundary of the Fort Hall Indian Reservation by 82 acres (0.03 %). This land would be available for the exercise of Tribal treaty rights as well as Shoshone-Bannock Tribal timber and grazing rights (e.g., 72 AUMs, Section 3.5.3.) (long-term, minor, beneficial effect to Tribal treaty rights).

The BLM would acquire the water rights for the Broken Wing Ranch, and would work to increase the flow in Lyon Creek to benefit fisheries resources and riparian vegetation, and fish passage to Lyon Creek would be improved by the removal of a pond/dam near the mouth (long-term, negligible to minor, beneficial effects to Tribal treaty rights for subsistence fishing). There would be economic value to the Shoshone-Bannock Tribes if preference Tribal grazing or timber harvest occurred on the Garden Creek property (e.g., 72 AUMS x $14.50/AUM = $1,044.00) (long-term, minor effect). The Shoshone-Bannock and Nez Perce tribes would not

have the opportunity of obtaining economic value from hunting, fishing, and gathering on a net decrease in unoccupied Federal lands (long-term, minor, adverse effects).

There would no longer be Federal oversight of the cultural sites on the selected land. However, as the sites are not eligible for the NRHP, the BLM is not required to preserve them (long-term, minor, adverse effect). The cultural sites on the ranch are in areas that would continue to be managed for agriculture, and there would be no adverse effects to these sites. One of the sites is eligible for the NRHP and another is considered unevaluated for the NRHP. These two sites would have Federal oversight and would be managed under the Challis RMP (long-term, moderate, beneficial effect). There are no known cultural sites at the Garden Creek property. Under Alternative L2-B compared to Alternative L2 there would be easier Tribal access to the ranch and the Lyon Creek drainage (long-term, minor, beneficial effects).

4.14.2.3. Alternative L3 – Land Sale

There would be a decrease of approximately 4,450 acres of unoccupied Federal land in the BLM Challis Field Office area, approximately 0.5 percent of the unoccupied Federal land in the BLM Challis Field Office area (long-term, minor, adverse effect).

4.14.2.4. Alternative L4 – Reduced Area Land Exchange, Fee Simple

There would be a decrease of approximately 2,390 acres (~ 0.3 %) of the unoccupied Federal land in the BLM Challis Field Office area from disposal of the selected land, and an increase of perhaps 400 acres (0.05 %) of unoccupied Federal land in the BLM Challis Field Office area due to acquiring approximately 30 percent less by fair market value of the ranch (long-term, minor, adverse effect to Tribal treaty rights). The Garden Creek property also may not be acquired (long-term, minor, adverse effect to Tribal treaty rights compared to Alternative L2).

If the water rights associated with the ranch subparcels along Lyon Creek were eliminated from the land exchange, there would be no effect on water quantity in Lyon Creek or the Salmon River. If the portion of the ranch with the dam and pond proposed for removal (BWR-2) were not acquired by the US, the benefits to fish movement between Lyon Creek and the Salmon River would not occur (long-term, minor, adverse effects to Tribal treaty rights compared to Alternative L2). The effects to the 10 prehistoric cultural resource sites on the selected land would be the same as for Alternative L2 because all of the sites would be in the reduced area of selected land (i.e., the remaining selected land that would leave Federal jurisdiction). Any prehistoric cultural resources sites on portions of the ranch not acquired by the US would remain privately managed.

4.14.2.5. Alternative L5 – Reduced Area Land Exchange, Easement

The effects to Tribal treaty rights related to the selected land would be essentially the same as for Alternative L2 because there would be effects in the foreseeable future for the portion of the selected land that would be subject to the conservation easement, even if the easement was not obtained by the BLM. The effects to Tribal treaty rights related to the offered lands would be essentially the same as for Alternative L4. Slightly more of the ranch and/or the Garden Creek property would be acquired by the US, but not enough to change the magnitude of the effects compared to Alternative L4.

4.15. Cultural Resources

4.15.1. MMPO Alternatives

4.15.1.1. Alternative M1 – No Action

Under the No Action Alternative, there would be no effects to NRHP-eligible cultural resources. The nearby NRHP-eligible cultural sites would not be affected by mine-related traffic or activities.

4.15.1.2. Alternative M2 – MMPO as Submitted by TCMC

The Cinnabar/Bruno Creek Mine/ lithic scatter (10CR758) has been determined to be eligible for the NRHP and a portion of the site would be located within the MMPO area. This site would be adversely affected under Alternative M2 in the long term. Mitigation and further consultation related to this site is described in Section 4.21.6. The other eleven cultural resource sites within the MMPO area are not eligible for the NRHP; two NRHP-eligible sites are located outside of MMPO boundaries (SHPO 2011).

4.15.1.3. Alternative M3 – No Name Waste Rock Storage Facility

The effects to cultural resources would be the same as under Alternative M2 as there are no known cultural resources in the area of the proposed No Name WRSF; there would be no effects to NRHP-eligible cultural resources (no effect).

4.15.2. Land Disposal Alternatives

4.15.2.1. Alternative L1 – No Action

There would be no change in the jurisdiction of cultural resources (no effect). The NRHP-eligible cultural site near Forest Service Road #040 would have the potential for inadvertent alteration via recreational use or damage via unauthorized collection and vandalism. Cultural resources at the Broken Wing Ranch and Garden Creek property would not have consideration/protection under Federal laws and regulations.

4.15.2.2. Alternative L2 – Land Exchange Proposal

Two potentially NRHP-eligible and five NRHP-eligible cultural sites would come under BLM administration and would then be afforded consideration/protection under Federal laws (long-term, moderate beneficial effect). No cultural resource sites are known at the Garden Creek property (no effect). Any future actions/activities on the ranch or the Garden Creek property would require compliance with the NHPA of 1966 (as amended) as well as any other applicable Federal law or regulation.

4.15.2.3. Alternative L3 – Land Sale

The cultural resource sites on the selected land would leave BLM administration, but these sites have all been determined by SHPO (2011) as not eligible for the NRHP (no effect). The cultural resource sites (including NRHP-eligible sites) on the Broken Wing Ranch would remain under private ownership (no effect). The Garden Creek property would also remain under private ownership (no effect).

4.15.2.4. Alternative L4 – Reduced Area Land Exchange, Fee Simple

The effect to cultural resources on the reduced area of selected land would be the same as under Alternative L3 (regardless of how many fewer cultural sites would leave Federal ownership). There would probably be fewer NRHP-eligible cultural sites that would come under BLM administration. Any future actions/activities on the ranch or the Garden Creek property under BLM administration would require compliance with the NHPA of 1966 (as amended) as well as any other applicable Federal law or regulation.

4.15.2.5. Alternative L5 – Reduced Area Land Exchange, Easement

The effects to cultural resources would be the same as for Alternative L4.

4.16. Transportation, Access, and Public Safety

4.16.1. MMPO Alternatives

4.16.1.1. Alternative M1 – No Action

There would be no material changes relating to transportation, access, and public safety for the mine through 2016 (during molybdenum production/full mining). For example, there would be the same (TCMC and non-TCMC) traffic volumes at the mine and in the mine region with TCMC traffic comprising approximately 40 percent of the traffic on SH 75 between the TCM Access Bridge and the junction of SH 75 with US 93. The rate of (TCMC and non-TCMC) highway traffic accidents would be unaffected. The rate of traffic accidents and occupational injuries or illnesses at the mine would be expected to be the same or slightly less due to continued efforts to increase safety. No occupational fatalities and no highway spills of molybdenum are reasonably foreseeable.

During the first 3 years of core reclamation under Alternative M1 the TCMC workforce would decrease to approximately 220 employees, but the mine would receive a similar amount of miscellaneous traffic. For the next 5 years of late-stage reclamation (i.e., monitoring and maintenance) the workforce would decrease to approximately 20 employees with an average of approximately five miscellaneous roundtrips per day. The workforce would then decrease to approximately 5 employees for long-term reclamation with an average of potentially one or two miscellaneous roundtrips per week (Doughty 2012). Therefore, TCMC traffic would be reduced throughout reclamation proportional to the number of employees, i.e., the TCMC traffic would be 20 percent of the traffic on SH 75 during core reclamation, 2 percent of the traffic during late-stage reclamation, and 0.5 percent of the traffic thereafter. There would be proportional decreases in the potential rate of TCMC traffic accidents on SH 75 and no chance of molybdenum spills.

After reclamation the lower portion of Thompson Creek Road would probably be maintained by the Forest Service instead of TCMC, and the lower portion of S. Creek Road would probably be maintained by Custer County instead of TCMC. It is unknown who would be responsible for maintaining the TCM Access Bridge in the long term. There would also be short-term wear from TCMC traffic on the surface of SH 75, and to a much lesser degree on the surface of US Highway 93 (the highways are typically resurfaced on a 7 year cycle).

4.16.1.2. Alternative M2 – MMPO as Submitted by TCMC

The mine would operate in the same basic manner with the same overall traffic patterns (and the regional traffic patterns are not expected to materially change in the foreseeable future). However, the effects related to transportation, access, and public safety during mining would occur through approximately 2025 instead of 2016, and the effects during core reclamation would occur from approximately 2025 to 2040 instead of from approximately 2016 to 2031.

4.16.1.3. Alternative M3 – No Name Waste Rock Storage Facility

There would be construction of a haul road approximately 300 feet in length and 70 feet in width to the upper No Name Creek drainage from the upper mine site, and the substantial improvement of the existing two-track road that begins at the base of the drainage (MP 5.2 on Thompson Creek Road) to a year-round mine access road of approximately 20 feet in width (long-term, minor effects).

The BLM would also grant an exclusive easement to TCMC for use of No Name Road, and TCMC would install a gate at the start of the road. There would be daily TCMC traffic (mostly haul trucks) on the upper road to the No Name WRSF during much of the mining through 2025 and to a lesser extent during reclamation through 2031, with a proportional decrease in traffic to the Pat Hughes and Buckskin WRSFs. There would be daily TCMC traffic on the No Name Road during the initial construction of the No Name WRSF, and weekly TCMC traffic on the road to monitor water management facilities (i.e., pipeline and sedimentation pond) and to collect water samples from the toe area of the facility (negligible effects, except a long-term, minor effect for the gate at the start of No Name Road).

4.16.2. Land Disposal Alternatives

4.16.2.1. Alternative L1 – No Action

Transportation, access and public safety related to the selected land would be the same as present, and the same transportation network and the same (TCMC and non-TCMC) traffic volumes would occur in the mine region with the same public access on North Slate Creek, Thompson Creek, S. Creek and Bruno Creek roads, and branches to these roads. However, the land disposal provisions related to transportation and access (Section 2.2.7.) would not occur.

There would be no public safety issues for the offered lands. The Broken Wing Ranch would have the same transportation network. Short portions of road may be developed adjacent the Salmon River if some of the riverfront property of the ranch was developed into exclusive residential/recreational property. The public and the BLM would not obtain access to the ranch, including vehicle access to the Lyon Creek drainage and to Leuzinger Spring at the end of Leuzinger Spring Road (Figure 2.2-3). Traffic on the ranch would continue to be one or two vehicle roundtrips and a few OHV trips per day, and perhaps less than a dozen people per year would visit the upper Lyon Creek drainage. Boaters would not have legal access to upland areas along 4.4 miles of Salmon River frontage. The public and the BLM would not gain access to the Garden Creek property. There would not be roads constructed on the property unless it was developed residentially. The property would continue to be visited by perhaps one person per year. The Challis East Subdivision Trail would not be developed.

4.16.2.2. Alternative L2 – Land Exchange Proposal

There would be no meaningful effects to public safety for the selected land. There would be no effects to transportation or access related to Thompson Creek Road and S. Creek Road, i.e., public access would be retained via easements to the BLM. No changes are foreseen in the public tours of the mine currently provided by TCMC, but the public would probably not be able to visit the mine on a BLM-sponsored annual tour pursuant to 43 CFR 3809.900.

The BLM would grant the owners of the Twin Apex a non-exclusive (non-public) easement prior to the land exchange for permanent access to their property via the Bruno Creek Road. The public would have essentially the same hiking access to the selected land, via the IDFG Access Yes Program (assuming approval by the IDFG) (negligible effects). However, the BLM and public would acquire access to certain roads and potential trails, and to large areas of associated Federal land via the land disposal provisions (Section 2.2.7.) (long-term, moderate effect).

First, the public would acquire permanent legal access to the South Butte Road, which branches east from S. Creek Road at MP 1.7. The start of the South Butte Road and one other portion of the road are on property owned by TCMC. The company has allowed public access on the road, but it is unknown how long such access would continue without a recorded easement, e.g., the property could be sold and the new owner may close the road. Permanent legal access to South Butte Road would ensure continued, ready access to more than 7,000 acres of BLM land typically accessed by the South Butte Road due to the land jurisdiction patterns in the locality, the extremely rugged topography, and the absence of other roads (long-term, moderate effect).

Second, the BLM would acquire administrative access to use roads on private property controlled by TCMC to reach the Saturday Mountain pasture of the S. Creek Allotment. The area is now essentially inaccessible to the BLM and its permittees (without permission from TCMC to cross its property) due to the land jurisdiction patterns in the locality, the rugged topography, and the existence of only one private road leading into the area. The right to use these roads would provide ready access to approximately 2,500 acres of Federal and State land, excluding the selected land (long-term, minor effect).

Third, the public may acquire 1.5 miles of access through a large tract of land owned by TCMC in the Challis East subdivision. The trail would be used by perhaps one or two people on each weekday, and five or 10 people on weekends, and would connect to the extensive BLM Blue Mountain Trail System to the west, and possibly (with future easements from other property owners) to the Salmon River to the east. Either the BLM or the City of Challis could accept the easement for the trail from TCMC, but would do so only if the trail would be supported by most of the property owners in the subdivision (long-term, minor effect).

There would be an increased probability of vehicle accidents on the ranch (long-term, minor effect). However, the transportation network on the ranch would remain essentially the same, apart from minor road improvements. Any development of a campground or recreational or interpretive facilities would utilize primarily existing roads, apart from perhaps internal campground loop roads (negligible effects). Under Alternative L2-B only the main ranch roads would remain in the long term, and approximately 10 miles of dirt two-tracks (used only for ranch operations) would be eliminated (negligible effect). The southern road on the ranch would

also provide access to Lyon Creek Road all year, and using the southern road would be shorter (0.9 mile) than using the Sink Creek and Lower Sink Creek roads to access the Lyon Creek Road (long-term, minor effects).

The BLM and the public would gain access to the ranch via Poverty Flat Road (the Lyon Creek Bridge would have only BLM administrative access). The public would also be able to access all of the ranch during the non-growing season (mid-October to mid-April), but would not be allowed in the cultivated fields during the growing season. There would be only non-motorized access on Lyon Creek Road to the Lyon Creek drainage starting from near the main ranch house next to Lyon Creek (or starting 1.3 miles further on Lyon Creek road near the western edge of BWR-1 under Alternative L2-B). However, the public would gain ready access to these points and 10,500 acres of BLM land in the Lyon Creek drainage via the main ranch road on the west side of the Salmon River (long-term, moderate effects).

The public would also gain ready access to 4.4 miles of Salmon River frontage, including a new parking area. There would not be public access to the two private parcels (2.5 acres each) with houses donated by TCMC to Custer County, except to use the roads that pass by or through the parcels. There would also be firearm safety zones around the two ranch houses on these parcels. The BLM would also acquire vehicle access to Leuzinger Spring and Lyon Creek via the Broken Wing Ranch (Figure 2.2-3). The access to Lyon Creek would allow the BLM to obtain valuable fish monitoring data in the long term (TCMC currently allows the BLM full access to the ranch, but previous owners have not allowed the BLM to collect data on the ranch or to pass through the ranch to access BLM land north of the ranch including all of Lyon Creek). These effects to access and public safety overall would be long-term and moderate.

Traffic on the main ranch road would increase on average by perhaps a few vehicle roundtrips per week during summer and fall, with much of the traffic concentrated on weekends and headed toward the Lyon Creek drainage. Development of a campground would cause an additional increase on average of perhaps three vehicle roundtrips per day during the summer, fall, and the March steelhead season, again with much of the traffic concentrated on weekends. The vehicles would be mostly cars and pickup trucks, but there would be some ATVs and motorcycles. None of the increased traffic would occur near residences currently adjacent to the ranch, but the increased traffic would be noticeable at a distance to nearby residents (long-term, moderate effects).

There would be no effects to transportation or public safety at the Garden Creek property, which would remain undeveloped. However, as Federal land, the property would be visited by possibly a few more people each year (long-term, minor effect).

4.16.2.3. Alternative L3 – Land Sale

The effects related to the selected land would be the same as for Alternative L2, unless the land was sold to a party other than TCMC. In such case the access provisions of the land disposal action alternatives (Section 2.2.7.) would not occur (long-term, major effects). There also would not be an opportunity for the BLM, if necessary, to establish a safety zone (public closure order) around the mine (negligible effect).

4.16.2.4. Alternative L4 – Reduced Area Land Exchange, Fee Simple

There would be no effects related to the reduced amount of selected land. That is, there would be no roads in the reduced area of selected land and the BLM and public would have the same (limited) access to the mine locality as under Alternative L1. Acquiring less of the offered lands would reduce the transportation routes and access that would be available to the BLM and the public compared to under Alternative L2, with a somewhat proportional reduction in traffic on roads on the ranch. In addition, depending on which lands were not acquired, there may not be access along the Salmon River and Lyon Creek, there may not be access to recreational facilities and interpretive sites, and there may be subdivision development along the Salmon River (4.4 miles) and Lyon Creek (0.9 miles). For all possible configurations of less offered lands, the effects would probably be long-term and moderate.

4.16.2.5. Alternative L5 – Reduced Area Land Exchange, Easement

Under Alternative L5, compared to Alternative L1, there would be no differences in the effects to transportation, access, or public safety for the selected land, even with a conservation easement on approximately 1,500 acres of the land. That is, there are no roads in the easement area, and the public would have non-motorized access to the easement area under Alternative L5, as well as under all of the other land disposal alternatives, e.g., via the IDFG Access Yes Program in the case of Alternative L2.

Acquiring less of the offered lands would somewhat proportionally reduce the effects to transportation and access compared to under Alternative L2. This effect would be long-term and minor to moderate, unless the reduction in land would not allow the BLM and public to access the Lyon Creek drainage, the Salmon River frontage along the ranch, or would allow subdivision and development along the Salmon River and Lyon Creek (long-term, moderate to major effect).

4.17. Hazardous Materials and Solid Waste

There would be no change to hazardous materials, solid waste, or petroleum product transport, use, storage or disposal at the mine under any of the MMPO alternatives, except that the use of such materials would continue for a longer duration under Alternative M2 and Alternative M3 compared to under Alternative M1. All storage areas for these materials have secondary spill control features (e.g., containment sumps and/or double wall tanks) to prevent release of the spilled material to the environment. There would always be a small probability for these materials to spill until reclamation was complete. The most probable spills would be fuel, hydraulic oil, and coolant from mobile equipment. However, the mine would address all spills under its Spill Prevention, Control, and Countermeasures Plan (ARCADIS 2010) (long-term, minor effects).

There would be no hazardous materials or solid waste at the selected land under any of the land disposal alternatives. The only hazardous materials or solid waste at the Broken Wing Ranch would be common household/farm items such as fluorescent light bulbs and batteries and fluids (e.g., oil and antifreeze) in vehicles and equipment. Under the land disposal action alternatives there might be a slightly lower or a slightly higher probability of environmental damage from hazardous materials or solid waste at the ranch due to Federal ownership. For example, lease/contact compliance inspections would help ensure compliance with regulations regarding

hazardous materials and solid waste, but there is generally a higher probability of illegal dumping on Federal land than private land (long-term, minor effect). There would be no hazardous materials or solid waste at the Garden Creek property under any of the land disposal alternatives, unless such materials or waste were illegally dumped at the property. The probability of illegal dumping at the property is extremely low and would be the same for all of the land disposal alternatives.

4.18. Unavoidable Potentially Significant Adverse Effects

Unavoidable in this section refers to effects that cannot be reasonably mitigated. *Significant* in this section in most cases refers to effects classified as major. *Adverse* in this section is from the perspective of the majority, e.g., exposing rock layers in the walls of an open pit would be beneficial to a geologist, but most people would consider such as adverse to visual resources. This section is applicable to only action alternatives.

Soil profiles/textures would be damaged (compacted) or destroyed (removed) on large areas (100s acres) of the mine, with a decrease in soil nutrients, organic matter, and microbial communities. The salvage, storage, and replacement of soil would result in a soil loss of approximately 30 percent, and many of the reclaimed areas would have less soil than the pre-mine condition, e.g., 1 foot or less depth on the reclaimed WRSFs. Large areas of vegetation would be removed at the mine, and re-established during reclamation. However, the re-established vegetation would have relatively low productivity for decades, particularly since vegetation growth is relatively slow at high elevations. Large areas of conifer forest, including scattered, large-diameter trees (but not old growth), would be removed by the mine operations. These trees would be a source of seed cones that may produce trees that are particularly resistant to drought and disease. Even with tree seedlings planted as part of reclamation, conifer forests would not develop to their current stature and diversity for at least 150 to 200 years.

The flow of groundwater near the open pit would be into the pit until the pit begins to fill, and the developing pit lake would not function ecologically as a natural lake. In addition, as the pit fills, the flow of groundwater near the pit would gradually reverse causing the pit lake to affect the quality of groundwater near the pit. Development of the No Name WRSF (Alternative M3) would probably affect groundwater in a new drainage. The mine would fill a variety of WUS. The Pat Hughes WRSF (Alternative M2 and Alternative M3) and the No Name WRSF (Alternative M3) would not meet the VRM Class II designation from KOP 6 in the short term. The No Name WRSF (Alternative M3) would not meet the VRM Class II designation from KOP 2 in the short term. The mine development would be a distinct change in land use (timberland to molybdenum mining) in the short term.

Under Alternative L2, Alternative L4, and Alternative L5 the area suitable for grazing in the Thompson Creek Allotment Lower pasture and Unit 2 pasture would be reduced by 69 to 80 percent (71 to 80 % of the AUMs). Under Alternative L2-B there would be a distinct change in land use (farm/ranch to native vegetation/no grazing) and substantial costs to the BLM Challis Field Office annual budget and the operator of the Broken Wing Ranch.

4.19. Short-term Uses Versus Long-term Productivity

The goal of this section is to evaluate the extent to which, if at all, the alternatives would balance short-term uses of (or effects to) a resource with long-term productivity of (or effects to) the resource, i.e., provide a sense of the resilience (or sustainability) of a resource to short-term perturbations associated with an alternative. For example, a short-term construction detour in a business district could cause the district to collapse, affecting long-term economic productivity; or a short-term removal of soil from a large area could result in that area having a long-term decrease in agricultural or timber productivity. The relationship between short-term uses of the environment and the maintenance and enhancement of long-term productivity is applicable to only action alternatives. Short-term in this section refers to uses with a duration of a few years or less.

Most effects of the MMPO action alternatives would be long-term, e.g., soil compacted and/or removed from the WRSFs. However, soil would be compacted and/or removed in small areas (e.g., few acres) at the mine that would be reclaimed in the short term, e.g., maintenance work in utility corridors. Such short-term effects to soil would cause a minor effect to long-term soil productivity, particularly on steeper slopes or areas of relatively erodible soil. For example, it would take decades to re-establish any biological crusts. It would also take several thousand years to regenerate the original soil profile and texture at a typical soil production rate of 1 inch per 1,000 years, a typical soil loss of 30 percent for salvaged soil, and a salvaged soil layer approximately 1 foot thick. Similarly, small areas of sagebrush, grassland, and conifer forest would be removed in the short term at the mine, but despite immediate reclamation there would probably be minor effects to the long-term productivity of such plants and trees. In the case of Alternative L2-B, the short-term conversion of approximately half the ranch to native vegetation would result in long-term increases in native vegetation and forage for wildlife.

The effects of the land disposal alternatives would also be long-term. There would not be any short-term uses that would affect the long-term productivity of a resource.

4.20. Irreversible and Irretrievable Commitments of Public Resources

Irreversible commitments occur when a resource is permanently affected, consumed, or renewable only over long time spans, e.g., natural soil development of approximately 1 inch per 1,000 years. Irretrievable commitments occur when a resource is not consumed or destroyed but rather becomes unavailable for use for the foreseeable future, e.g., a decrease in public recreation opportunities due to a sale of Federal lands. This section is applicable to only action alternatives.

The mine would cause the permanent removal of a substantial amount of molybdenum. If the removal of molybdenum from private property were considered a "public" resource, then such removal would result in an irreversible commitment of public resources. The transfer of the selected land from Federal to private ownership would be an irretrievable effect on public availability of the mineral resources on the property. However, the known mineral resources would be extracted for the benefit of the public, the land would be managed by TCMC primarily for mineral development, and the probability of discovering additional valuable mineral deposits on the land would be remote.

Soil that would be distinctly compacted or salvaged at the mine would be an irreversible commitment because of the slow rates of natural soil regeneration. Similarly, the removal of conifer forest would be an irreversible commitment because of the slow rates of tree regeneration. Removal of shrubland and grassland (and 2 or 3 AUMs in the Thompson Creek Allotment) might be an irreversible commitment depending on how long it would take to re-establish the vegetation. Wildlife would be displaced from the mine site. The water used to fill the pit would be an irretrievable commitment of water resources affecting the hydrologic balance of the locality. The effects to the quality of surface water, groundwater, and fish habitat would be irreversible commitments, as well as the fill of the WUS (which would be greater under Alternative M3 than Alternative M2). However, the fill of WUS is fully mitigated (Appendix B). The open pit, WRSFs, and TSF would be irreversible effects to topography and visual resources, although reclamation would minimize the effects of the WRSFs and the TSFs to visual resources.

There would be an irretrievable commitment at the mine related to land use (conversion of timberland to molybdenum mining), and in some areas of the selected land there would be an irretrievable commitment of recreation resources (small areas that would not be available for public access). The mine would also require irreversible commitment of labor and fiscal resources, some of which might be considered public resources. There would be an irreversible commitment of one cultural site (not eligible for NRHP listing), and the potentially undiscovered cultural and paleontological resources in the areas in which the surface would be disturbed by mining. There would also be an irreversible commitment of unoccupied Federal land under the MMPO alternatives, and also (net decrease in Federal ownership of up to approximately 5,100 acres) under the land disposal alternatives. Under Alternative L2-B there would be an irretrievable commitment related to land use (conversion of a farm/ranch to native vegetation and eliminating grazing from a portion of the farm/ranch).

4.21. Mitigation and Monitoring

In addition to the mitigation and monitoring described below, adaptive management (Table 2.1-2) would be utilized in conjunction with monitoring (Table 2.1-4. and Table 2.1-7.) to ensure reclamation goals are met.

4.21.1. Geologic Resources and Geotechnical Issues

The following measures would be implemented under all MMPO alternatives. If unanticipated paleontological resources were encountered during mining, TCMC would immediately notify the Forest Service or the BLM authorized officer, and operations would be halted in the vicinity of the discovery until inspected by the Forest Service, the BLM, or an agency-approved paleontologist, and a mitigation plan developed, if necessary. Paleontological resources would be avoided until the Forest Service, the BLM, or an agency-approved paleontologist conducts investigations as needed to determine the significance of the fossils. At the discretion of the Forest Service or the BLM, these fossils would be avoided for a length of time that is reasonable (i.e., at least 10 days after notification to the authorized officer of such discovery) to allow agency personnel to conduct the investigations. TCMC would be responsible for the cost of these investigations, evaluations, and mitigations.

4.21.2. Vegetation, Forest Resources, and Invasive and Non-native Plants

The trees planted for reclamation could include whitebark pine seedlings in all disturbed areas within 100 vertical feet of ridgetops with an elevation of 7,300 feet or more, e.g., the head of the Buckskin Creek drainage. Such would result in stands of whitebark pine trees (long-term, moderate effect).

4.21.3. Water Resources

The Consolidated Environmental Monitoring Program 2007 to 2012 for the mine contains a Water Quality Monitoring Plan and Adaptive Management Plan (TCMC 2008a, Section 2.1.1.7). The program would be modified according to Lorax (2012b) to better identify potential water quality problems due to either inaccurate predictions or to operations (e.g., cutoff walls) not performing as intended. For example, the adaptive groundwater management Plan (Lorax 2012b) notes that additional groundwater monitoring in the colluvium and metasedimentary bedrock just downgradient (within 30 feet) of the cutoff wall should provide a better evaluation of the cutoff wall performance and hydraulic gradients between the cutoff wall and the drainage outlet. In addition, water level monitoring just upgradient of the cutoff walls using automated piezometers (for safety purposes at the toes of the WRSFs) would allow the determination of the hydraulic gradient across the cutoff wells, which would also provide a better evaluation of the cutoff wall performance. Furthermore, the Phase 8 pit wall could be mapped for major faults/fractures that could convey pit lake water to the groundwater near the pit. Such data could be integrated into a subsequent groundwater monitoring system to evaluate the potential effects of the pit lake on groundwater. The Lyon Creek ford at the Broken Wing Ranch could be armored to reduce downstream turbidity and sediment deposition.

4.21.4. Wetlands, Floodplains, and Riparian Areas

The wetland and stream mitigation plan (HDR 2014b) would mitigate the effects of the MMPO alternatives on WUS (Appendix B). The objective of the proposed wetland and stream mitigation is to protect streambanks along S. Creek from damage caused by livestock and to reestablish a 5.64-acre wetland along S. Creek. Protecting the streambanks would be accomplished by fencing out livestock and the repair or restoration of 100 feet of bank using bio-engineering as described in the wetland and stream mitigation plan (Appendix B). Reestablishing the wetland would involve earthwork and plantings. Contractors would be required to implement a SWPPP during the construction and vegetation establishment phase of the wetland and stream channel rehabilitation work.

Over time it is expected that fencing S. Creek to exclude livestock would naturally allow rehabilitation of the streambanks along S. Creek. The natural processes would include reestablishment of the riparian vegetation and a reduction in erosion along the streambanks. The reestablishment of vegetation would reduce sediment load and benefit water quality. Additional vegetation along the S. Creek streambanks would create more shade, which could have minor benefits on the water temperature and would create additional habitat and cover for wildlife. Fish and aquatic resources would benefit from the reduction in turbidity and water temperature and would have higher-quality streambank habitat. The fencing would not interfere with wildlife access to S. Creek.

The proposed new wetland that would be developed as part of the mitigation would be located between the gravel access road and S. Creek. Based on observations in the field, it is likely that this area was a wetland that was drained and filled in the past. Once completed, following the vegetation establishment phase (1-3 years), the wetland would provide habitat for breeding, foraging, and cover for birds, water fowl, mammals, reptiles, and amphibians. The restored wetland would be fenced to control access, and manage potential grazing rotations. The proposed stream and wetland mitigation would have negligible effects on the overall ecosystem of the S. Creek drainage.

4.21.5. Visual (Aesthetic Resources)

The effect of the No Name WRSF on visual resources could be reduced in the long term by planting trees to partially block the view of the facility from KOP 2 and other areas along Thompson Creek Road. If trees were planted at or before the initial development of the facility, the trees would reach a size to break up or block views by the time the facility would be visible from the KOP. Reclamation could also include measures to reduce effects of the WRSFs and the TSF such as regrading the margins of the facilities in a "feathering" pattern to better blend with the surrounding topography. The rock features most visible due to color contrast could also be stained (oxidized) to reduce the contrast.

4.21.6. Cultural Resources

The adverse effect related to the Cinnabar/Bruno Creek Mine/ lithic scatter (10CR758) would require the development and approval of a cultural resource mitigation plan and further consultation with the SHPO, National Advisory Council, and the Tribes. Completion of the NHPA Section 106 consultation process would require a ground survey of the site to determine which, if any, significant site components would be affected by the MMPO. If any site components that would contribute to the significance of the site would be adversely affected by the MMPO, then a mitigation plan would be developed, agreed upon, and implemented before any ground-disturbing operations could occur.

The measures described for the unanticipated discovery of paleontological resources (Section 4.21.1.) would be implemented under all MMPO alternatives for the unanticipated discovery of cultural resources.

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